# ICE AND FROST

Published every little while by

FRICK COMPANY, WAYNESBORO, PA.

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# ICE AND FROST

PUBLISHED
EVERY LITTLE WHILE
BY

## FRICK COMPANY
Waynesboro, Pa. U.S.A.

ICE MACHINERY
SUPERIOR SINCE
1882

Jack Frost,
Editor

IN THIS NUMBER:




FRICK COMPANY
631-632 JENKINS BLDG.
PITTSBURG

View of Frick Company Works, covering over 30 acres, one of the largest of its kind, employing a large force of skilled workmen

## EDITOR'S NOTE

IN this issue we give a brief explanation of the simple theory of refrigeration as applied to ice making, some interesting and valuable information regarding the ice-making industry, and a brief description of the publisher's different ice-making systems and equipment.

In writing this booklet we have drawn on the publisher's experience during the last forty years in the ice-making and refrigerating machinery business. The test of time has proven the machinery and equipment resulting from this experience to be the standard guide to excellence of design and efficiency.

The publisher maintains efficient engineering and estimating departments and no matter how large or how small the inquiry, it receives expert attention. Correspondence is solicited from all parts of the world since the publisher's product is adaptable to the economical production of ice and refrigeration everywhere, and is now being used in every part of the world.

Jack Frost

View in Frick Company's Pipe Shop

View in Frick Company's Tank Shop

# PART I

# THEORY OF REFRIGERATION

### AS APPLIED TO

# ICE MANUFACTURE

The cooling process of abstracting heat from liquid or solid bodies is refrigeration. Water or air, of a lower temperature than the body to be cooled, may be used to do the cooling. If temperatures of 40° Fahr. or above are desired, ice may be used, but for temperatures near or below the freezing point of water (32° Fahr.), freezing mixtures or refrigerating machinery must be used.

The simplest form of refrigerating apparatus may consist of two parts, a tank of cooling medium and an evaporator or congealer, as shown by Illustration No. 1. With this apparatus the refrigerating medium is allowed to escape from the tank into the evaporator or congealer as fast as the coils therein are capable of giving sufficient heat to it to vaporize the liquid into gas. If the resulting gas or vapor were allowed to escape into the atmosphere this would mean a total waste of the refrigerant and the supply would have to be maintained by adding additional tanks. This would be impracticable since the refrigerating medium is expensive.

To recover this gas and re-convert it into a liquid for use over and over again, instead of using an additional supply, will require some additional apparatus.

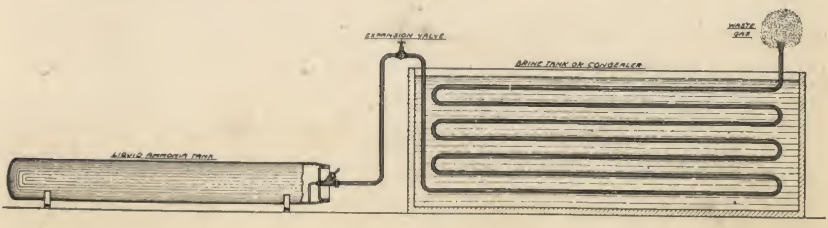



Illustration No. 1

The simplest form of refrigerating apparatus embodying this additional equipment would consist of three principal parts as shown by Illustration No. 2.

A is an evaporator or, as it is sometimes called, a congealer, in which the liquid refrigerating medium is vaporized due to the absorption of heat from the surrounding brine.

B is a combined suction and pressure pump called the compressor or refrigerating machine, which transfers the gas from the evaporator coils as fast as it is formed.

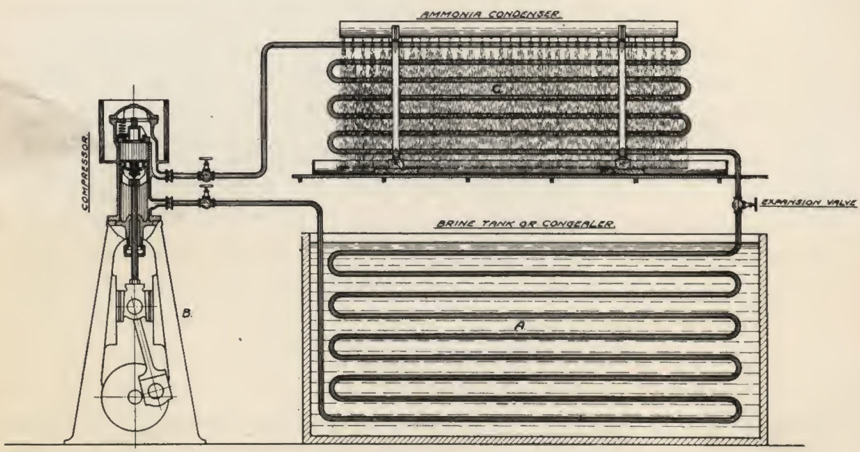



**Illustration No. 2**

C is a liquifier or, as it is commonly called, a condenser, into which the gas is discharged by the compressor. Under the combined action of the compressor pressure and the cold condenser surface the vapor is re-converted into its liquid state and used again in the evaporator or congealer.

Referring to Illustration No. 2, the apparatus is first charged with a sufficient quantity of the cooling medium, which is stored in the lower part of the condenser C. A small cock or expansion valve in the pipe leading to the congealer or brine tank A is opened slightly, allowing the liquid to pass into the evaporator coils. These coils perform the same office as a tube or flue in a steam boiler, and may, with equal propriety, be named the heating surface.

The amount of water converted into steam in a boiler depends on the number of square feet of heating surface, the temperature of the fire and the resulting pressure which the

steam exerts. The same is true of the capacity of the heating or heat-robbing surface of the coils in the evaporator. The heat is transmitted through these coils, being taken from the substance surrounding them and absorbed by the refrigerating medium. This heat causes the refrigerating medium to boil and creates a vapor, just as water when boiling gives off steam. As previously explained, the surrounding substance parts with an equivalent amount of heat and thus becomes cooler, this heat being transferred to the cooling medium where it is taken up and absorbed in proportion to the pounds of liquid evaporated. The quantity of liquid evaporated is under the control of the expansion valve leading from the condenser.

As the gas begins to form in the evaporator the compressor pump B is set in motion at such speed as to carry away the gas as fast as it is formed. This is discharged into the condenser under such pressure and temperature as will bring about condensation and restore the gas to its liquid state, ready again to pass through the expansion valve. This constitutes the refrigerating cycle, which is continuous so long as the compressor is kept in operation and the proper quantity of water is circulated over the condenser. The condenser water absorbs the heat of compression and the heat that the refrigerant has absorbed in the evaporator.

The successful action of all refrigerating machinery depends on well defined natural laws which govern in all cases, no matter what type of apparatus or machine is used. The principle is the same in all, although the process may vary slightly. Of course, the properties of the particular agent used and the manner of its use affect the efficiency or economic results obtainable.

As ammonia is the agent most commonly employed in the commercial plant of today, this text will deal primarily with the ammonia compression system.

The real index to the amount of cooling work done is the number of pounds of ammonia evaporated during an hour or day between the observed range of temperatures. To make this statement clear, it must be understood that every pound of ammonia, during evaporation, is capable of taking from the surrounding atmosphere and storing up a certain amount of heat.

A vessel of liquid ammonia thrust into a snow bank having a temperature of 32° Fahr. would bear about the same relation to a snow bank that a vessel of water of ordinary temperature would to a fire. In both of these cases there would result an evaporation of liquid and absorption of heat by the resulting vapor. The heat required to evaporate the ammonia would be taken from the snow bank which would be made even colder through the absence of this heat than it was before.

A popular idea of heat is that "it is hot enough to burn" and it is difficult for most persons to form any other conception of it. However, the absolute or real zero of the negative scale is 460° below the zero as it is known on the thermometer; therefore, it will readily be understood that within this great range it is more a question of the relative difference of temperatures between two bodies brought into contact which determines the amount of heat that one gives up and the other gains, than the exact position in degrees occupied by them on the thermometer scale. The hotter body will invariably continue to impart its heat to the colder body until the temperatures of both are equalized; and, in the case of ammonia, the boiling point of which is 27° Fahr. below zero, it will continue to boil at atmospheric pressure and to carry off heat as long as it is in contact with any substance hotter than itself, making that substance colder by robbing or absorbing heat from it until it has been reduced to a temperature corresponding to the pressure at which the ammonia gas is formed. When this point is reached, the ammonia ceases to evaporate and remains in a liquid state.

Pressure and temperature of gases are inter-related; that is, at a certain pressure saturated vapor has a corresponding temperature, and this is the case with ammonia. A vapor is saturated when it is still in contact with some of its liquid, and compression of this saturated vapor without change of temperature produces a proportionate amount of liquefaction; consequently if the vapor is discharged into an air-tight vessel, which is constantly kept cool by water of a certain lower temperature than that due to the pressure of the vapor, the vapor will necessarily, under these conditions, collapse and be condensed inside the vessel and return to its liquid form.

The temperature of the water available for use in the vessel, meaning the condenser, determines the pressure to which the vapor must be subjected in order to raise its boiling point high enough so that it cannot exist as a vapor when chilled by contact with the condensing surface but will collapse and condense.

The CRITICAL TEMPERATURE of a gas is that temperature above which no increase of pressure will cause liquefaction. All the so-called permanent gases are above the critical temperature and they can, therefore, not be liquified by the application of pressure unless their temperature is first reduced below the critical temperature. At this temperature the gas reaches a state at which the latent heat of evaporation is zero.

The pressure necessary for liquefaction at the critical temperature is called the CRITICAL PRESSURE and the volume of one pound of the gas at this point is called the CRITICAL VOLUME. For its determination it is compared with the volume of one pound of the same gas at 32° Fahr. and at atmospheric pressure.

The following table gives the critical temperatures and pressures as well as the boiling points at atmospheric pressure of various substances, as taken from accepted authorities:

CRITICAL TEMPERATURES, PRESSURES AND BOILING POINTS AT ATMOSPHERIC PRESSURE OF VARIOUS SUBSTANCES

| Substance | Critical Temperature Degrees Fahr. | Critical Pressure Lbs. Gauge | Boiling Point at Atmos. Pres. Degrees Fahr. |
|---|---|---|---|
| Air | —220 | 559 | —312 |
| Ammonia, $NH_3$ | +266 | 1,675 | — 27 |
| Carbon Dioxide, $CO_2$ | + 88 | 1,088 | —112 |
| Ethyl Chloride, $C_2H_5CI$ | +365 | 779 | + 54.5 |
| Hydrogen, H | —389 | 280 | —405 |
| Oxygen, O | —182 | 731 | —296 |
| Sulphur Dioxide, $SO_2$ | +314 | 1,160 | + 14 |
| Water, $H_2O$ | +689 | 2,925 | +212 |

When a body passes from the solid to the liquid state, or from the liquid to the gaseous or vapor state, a certain amount of heat is required to bring about the change. As this heat is absorbed during the process of fusion or vaporization it is called latent heat of fusion or latent heat of evaporation—latent heat contained in the vapor.

Since the latent heat of ice is 144, *i. e.,* since 144 B.T.U. (British thermal units) must be added to one pound of ice at 32° Fahr. to produce one pound of water at 32° Fahr., or in other words, one pound of ice melting into water at 32° Fahr. will absorb 144 positive units of heat, consequently it follows that water at 32° will require 144 negative units to convert it into ice.

Since the unit of refrigeration in this country is the number of B.T.U. which must be abstracted from one ton of water at 32° Fahr. in order to produce one ton (2000 lbs.) of ice of the same temperature, the unit of refrigeration is accordingly equal to 2000 x 144—288,000 B.T.U., this being called one-ton refrigeration.

The specified time in which this amount of refrigeration must be produced by a machine of one-ton capacity is 24 hours. Therefore, if a machine is said to have a refrigerating capacity of 50 tons, it means that the machine can produce 50 tons refrigeration in 24 hours. One ton of refrigeration in 24 hours is equivalent to the abstraction of $\frac{288,000}{24} = 12,000$ B.T.U. per hour, or $\frac{12,000}{60} = 200$ B.T.U. per minute.

Ice-making capacity is often taken at about one-half the refrigerating capacity, but this is only approximate. The tons of ice which a refrigerating machine will make depends on the following: The initial temperature of the water to be frozen; the temperature of the condenser water; the losses occurring from various sources; and the size and number of ice cans per ton and the number of square feet of pipe surface per ton, since these determine the back pressure at which the machine is operated.

The equations following show how ice-making capacity is accurately determined in terms of refrigerating capacity. As stated before, one pound of water at 32° Fahr. requires 144 negative heat units to convert it into ice, hence equation "A."

If the water to be frozen is taken from the usual source of supply, *viz.,* the city main, its temperature in midsummer may be as high as 90°. This must first be reduced to 32°, hence equation "B."

Manufactured ice is generally far below 32° because the

temperature of the bath in which it is made ranges about 12° Fahr., and this work must be added also, hence equation "C."

| | | |
|---|---|---|
| "A" | 2000 x 144 | = 288,000 |
| "B" | 2000 x (90-32) | = 116,000 |
| "C" | 2000 x (32-12) x .5 = | 20,000 |
| | | 424,000 |
| Add 10% for losses | | 42,400 |
| Total B.T.U. per ton ice | | 466,400 |

Hence $\frac{466{,}000}{288{,}000} = 1.6$ nearly, and therefore it becomes almost general practice to call one-ton ice-making capacity equivalent to 1.6 tons refrigeration.

In equations A and B, the specific heat is not taken into consideration because its value is approximately unity for water, but for equation C the specific heat to be used must be that of ice which has a value of approximately .5.

The time required to freeze various thicknesses of ice with various brine temperatures may be determined by the following formula:

$$T = \frac{(2 \times h)^2 \times 7}{32 - t}$$

Where $T$ = Time to freeze in hours,
$t$ = Temperature of the brine,
$h$ = Thickness of ice = ½ the thickness at top of cake for can ice.

The number of cans per ton ice depends on the time to freeze one can, which is determined by the brine temperature and thickness of ice to be frozen and the pounds of ice per can, and may be expressed by the following formula:

$$N = 83.4 \times \frac{T}{L}$$

Where $N$ = Number of cans per ton,
$T$ = Time to freeze one can in hours,
$L$ = Number of pounds of ice per can.

The number of feet of pipe per ton ice depends on the desired temperature of the brine, the temperature of am-

monia and the heat transfer per square foot of pipe surface, and may be expressed by the following formula:

$$F = \frac{44{,}180}{f \times t - t_1}$$

Where $F$ = Number of feet of $1\frac{1}{4}''$ pipe per ton ice,
$t$ = Temperature of the brine,
$t_1$ = Temperature of ammonia,
$f$ = Heat transfer per square foot per hour per degree of mean temperature difference. $f$ equals 22 B.T.U. for Frick flooded freezing systems for a $10^\circ$ temperature difference between brine and ammonia.

This subject might be carried further with the resulting discussion of details that then could not be avoided. It has been desired however to present only the elementary methods of arriving at a few of the principal elements of a plant. For a more advanced investigation the reader is referred to the numerous very excellent handbooks available.

**Ice Storage—Showing Frick Low Pressure Drop Pipe Raw Water Ice**

# PART II
# ICE-MAKING EQUIPMENT

## CHAPTER I

### Introductory

Ice has become one of the necessities of life. The ice-making and refrigerating industry today occupies the ninth position in magnitude in American commerce. And this position has been reached in a comparatively few years, since it is one of the youngest industries.

It is with pardonable pride that we point to the fact that Frick Company is a pioneer in the manufacture of ice-making and refrigerating machinery and has always kept abreast of the ever-growing ice-making and refrigerating industry. Plants of all accepted types from the smallest to the largest, including the latest improved methods that have proven by test to be worthy of adoption, are manufactured by Frick Company. The appreciation of the Company's efforts throughout forty years to maintain the highest standard of design and materials, as shown by the continual increase in its business and the number of its satisfied customers, is sufficient proof of its policy.

The comparative simplicity of the manufacture of artificial ice and the fact that it can be made close to its market out of the same water with which the community is supplied for household use, or out of distilled water, and at a cost low enough to compete with natural ice, has brought about its adoption everywhere.

The distilled water ice-making system which was largely used up to a few years ago has now been supplanted to a large extent by raw water systems. Of course, there are still a large number of distilled water plants in operation, and there are numerous cases where, on account of bad water conditions or due to an available supply of cheap exhaust

steam, distilled water plants are the best suited and most economical today.

The development of central power stations and water power plants is affording attractive current rates and in numerous localities after all conditions are considered it is found cheaper and better to buy power from one of these plants than to generate it. In other cases, where it is found to be more economical to generate the power, the use of modern uniflow engines, operating economically in connection with high vacuum steam condensers, is advisable. Such engines, however, do not use sufficient steam to provide the quantity of distilled water required. Then again, economy may dictate the use of gas producer or oil engines, either direct-connected or belted to the refrigerating machines.

The problem therefore has been to do away with the need of distilled water and the present-day raw water systems of ice making are the result. To make clear, merchantable ice from ordinary drinking water it is necessary to keep the water in lively agitation during the freezing period. Compressed air is used to produce this agitation.

There has been a wide development during the past ten years in raw water ice-making systems. The present-day systems are the result of much work and costly experimentation. Frick Company has played a large part in this development. Its modern ice plant is no longer an experiment in any sense of the word, but is a tried and proven equipment and is certain of success if properly installed and managed with ordinary care.

This booklet does not cover the refrigerating machine and compression system. These are covered in detail in other issues. This issue deals only with the ice-making system, since it alone forms a deciding factor in any plant.

Many of the parts of an ice-making system are common to all systems. These parts will be discussed and illustrated briefly before passing to a more detailed description of the different special parts forming the several accepted types or systems produced by Frick Company.

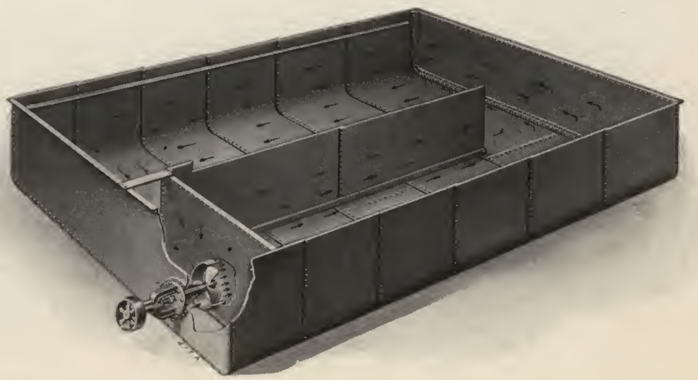
# CHAPTER II

## PARTS COMMON TO ANY ICE-MAKING SYSTEM

### Freezing Tank

Two general types of freezing tanks are made by Frick Company; one designed for domestic shipment and the other for foreign shipment. The domestic tanks are of the construction shown in the illustration, the sides and bottom being constructed from the same sheets properly bent at right angle and sufficiently rounded at the corner to permit the sheets being easily riveted together. The ends are flanged to provide the rivet lap. This is a most important point. The tanks are well braced by angle iron around the top. The tanks for foreign shipment are built up with flat sheets using angle iron at the corners, being so designed that all parts can be packed flat for ocean shipment, thus reducing the space required to a minimum. The raceways of all tanks are properly proportioned to insure free brine passage and keep friction as low as possible.

The steel tank sheets are punched for the rivets at the factory, and are so marked that when the instructions sent with each tank are followed the erecting engineer can assemble the tank correctly and with a minimum amount of labor. The primary requisite of a freezing tank is that it



Ice Freezing Tank—Assemble

shall be absolutely water tight and that the possibility of leaks developing be minimized. This condition is satisfactorily met in Frick tanks by making all joints metal to metal and caulking the seams. The use of paper or other kinds of fillers sometimes used for this purpose, and always liable to deterioration, is never tolerated in Frick tanks.

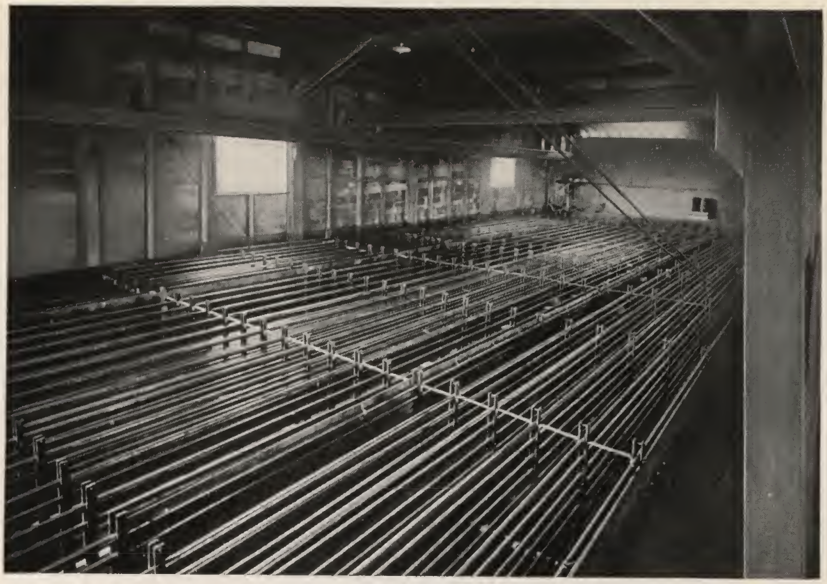
All parts are given a complete covering of water-proof paint before shipment.

## Evaporating Coils

Frick standard freezing tank coils are of $1\frac{1}{4}''$ selected ammonia pipe and made continuous by the electrical welding process in lengths up to approximately forty feet. Longer coils are made in two sections joined in the center by standard four-bolt ammonia flanges. The only other thread and gasket joints are those where these coils are joined to the ammonia feed and return headers; standard four-bolt ammonia flanges are also used for making these connections. The headers are of liberal size and threader joints are almost entirely avoided by using the well tried oxy-acetylene welded construction.

Great care is taken in the electric welding of the coils. The metal at the weld is made thicker than the pipe by upset-

**Erection of Tank Coils**



Tank Coils in Position

ting the pipe ends when the weld is made, care being taken not to reduce the internal sectional area at the weld beyond that of the pipe. The finished coils are tested with air at 300 pounds pressure under water. This type of coil construction is one of the greatest advances made in the refrigerating industry during the past ten years and it greatly reduces the possibility of leaks with a material reduction of erecting labor also.

In order to prevent the coils from becoming damaged in shipment they are carefully crated or braced with wooden stringers.

## Submerged Brine Coolers

For customers preferring brine cooler to evaporating coils, Frick Company has designed and built a line of substantial oxy-acetylene welded shell and tube brine coolers. These coolers are of the very best material and construction throughout, the tubes being standard 2″ charcoal iron tubes, the shells all made from one sheet of flange steel with only one welded seam and the heads made of ¾″ thick flange steel. The tubes are expanded into the heavy tube heads.

The freezing tanks for use in connection with these


Shell and Tube Brine Cooler

coolers, particularly the bulkheads and partitions, supports for the tank framework and can holders, have all been carefully worked out and proven satisfactory. All of these details can of course be made in numerous grades and types, but Frick Company has spared no expense to make them the best, for while appearing unimportant they play an important part as to convenience and durability.

## Frick Flooded Freezing System

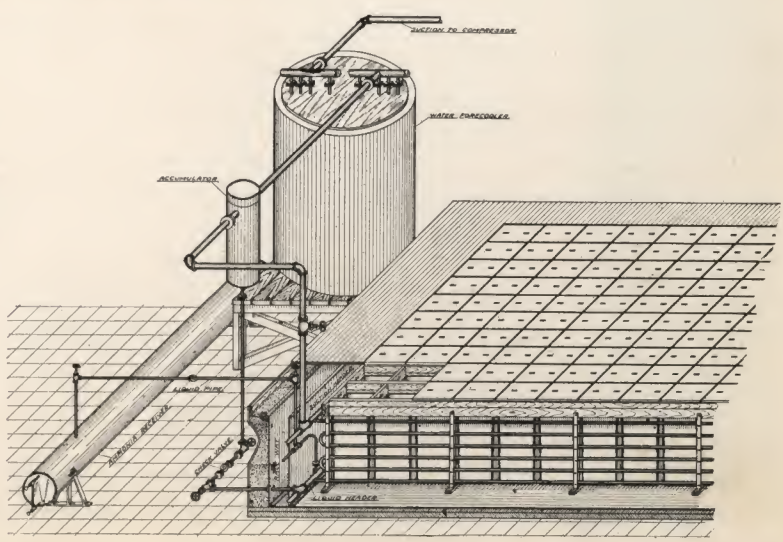
Practically all ice plants built by Frick Company within the past twelve years have been equipped with the Frick Improved Flooded System. This system possesses special virtues from the fact that with it the freezing tank coils are operated partially full of liquid ammonia. This flooded system, while working on a different principle has proven a success far beyond that originally claimed for it, and it is now the most efficient and economical system for the manufacture of ice. In it the ammonia is caused to circulate by natural causes.

The advantage of the flooded system over the old dry gas system is found in the fact that the heat absorbing surface of the pipe coils will transmit a far greater number of heat units between the warmer and cooler mediums with a liquid on

both sides of the pipe than with a gas on one side and a liquid on the other. In other words, the coil surfaces, when operated with a liquid on the inside and another liquid on the outside, are about 50% more efficient than when operated with gas on the inside and liquid on the outside.

A typical installation of the Frick Flooded System is illustrated below. The principal feature of this system consists in the use of such apparatus as will successfully separate the ammonia liquid from the ammonia gas returning from the freezing tank coils. Both come over from the coils toward the compressor in more or less intimate states and quantities, and it is essential to the successful operation of the system that the liquid and gas be separated.

As will be seen from the diagram, the suction line from the tank coils rises through a specially constructed trap, wherein this separation of the liquid from the gas is effected. This trap or accumulator is of sufficient size and depth to permit the liquid to drop to the bottom, while the gas passes off at the top and travels to the machine. The separated liquid is automatically returned to the coils and there is a constantly repeated circulation of the ammonia, thus producing the high efficiency.




**Frick Improved Flooded System**

The simplicity and dependability of the Frick Flooded System have made it a standard known the world over. It simplifies plant operation by reducing the number of feed valves to be regulated; it increases plant efficiency by insuring uniform operation and giving absolute control over the ammonia; it adds to plant safety by preventing priming accidents; and it lowers first cost by increasing the heat transfer through the evaporating surface, thus reducing the amount of surface required.

Accumulators as made by Frick Company, of sizes up to and including two feet in diameter, are built by welding suitable dished heads to welded pipe. All connections to the accumulator are likewise welded so that the finished accumulator contains no joints. The heads are scarfed and grooved, and the grooves filled with welding iron in order that the weld may be as strong as the pipe. This construction produces the best type of vessel known for the purpose.

Accumulator

The liquid which finds its way to the bottom of the accumulator is carried back by gravity to the freezing tank coils by means of a connection between the bottom of the accumulator and the liquid feed header. The gas, as it is formed, seeks the path of least resistance back to the compressor, and for this reason it endeavors to pass back through the liquid return line, thus creating the impossible condition of having gas and liquid connections at both ends of the accumulator and only one direction for both toward the machine. In order to overcome this difficulty and insure a fixed direction of flow, Frick Company has applied a special check valve placed in the liquid return line from the bottom of the accumulator to the liquid header. This valve opens whenever the head of the liquid in the pipe and accumulator is sufficient to overcome the action of the

valve spring. This check valve gives positive and satisfactory service with very little attention. The two stop valves, one on each side of the check valve, are so installed in order to make it easy to remove and clean the check valve should this be necessary on account of scale gathered from inside of pipes, etc.

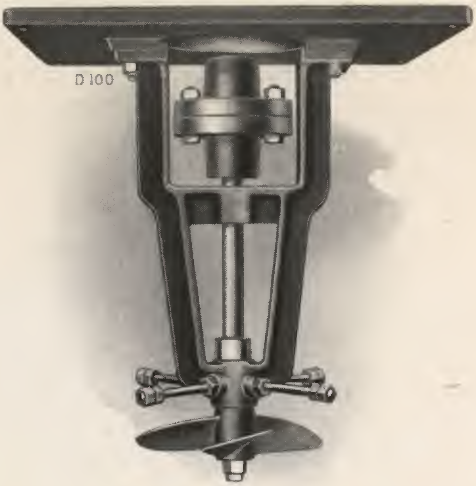
## Brine Agitators

The character of the brine circulation in the freezing tank is of great importance. A positive circulation must be produced to properly provide even temperatures at all points in the tank. If poor agitation exists, the coldest portion of the brine will always be at the bottom of the tank and immediately surrounding the ammonia coils, so that the ice will form quickly in the bottom of the cans, while at the top the freezing will be slow. This tardiness is a decided disadvantage and in practice often results in the drawing of the blocks of ice while they contain large unfrozen areas or cups. Poor agitation also causes the ice to crack, due to uneven freezing temperatures.

The question of brine circulation has been the subject of extensive experiments, the results of which have shown that the method which most satisfactorily meets the requirements consists in the use of a propeller agitator.

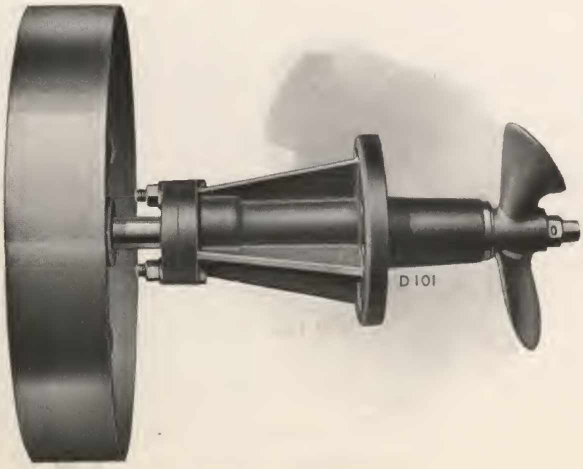
Two types of agitators are manufactured by Frick Company, *viz.,* horizontal and vertical, and they are furnished for belt drive and for direct connection to suitable motors. All parts used in their construction are liberally designed and will safely carry all reasonable loads met in practice; furthermore, the parts subject to wear are accessible and interchangeable. The bearings are made of high-grade babbitt and ample provision is made for lubricating them. The propeller blades are of proper pitch to circulate the correct quantity of brine at the speeds stipulated.

The matter of selecting a suitable agitator to meet certain conditions is a question worthy of the most careful consideration, as an improper agitator will act as a churn without providing circulation. This churning action generates heat which must be counterbalanced by added duty from the




Vertical Agitator

evaporating coils. Frick agitators are designed with large diameters and pitch, and will perfectly circulate the brine with a minimum heat loss.




Horizontal Agitator

Freezing Tank Framework

## Freezing Tank Framework

The standard tank framework constructed by Frick Company is simple and the most easily erected type known to us. It is made of green wood obtained directly from the mill, then air dried only to a certain point. The use of this lumber insures the framework against serious swelling after it becomes damp from use. All parts of the framework are carefully selected, and are shipped from the factory in such condition as to be very easily erected.

The framework is so designed that it may be built up in the tank or built up on the outside, then set down in the tank. The main stringers are heavy lumber, while the cross pieces between each can are lighter and are toe-nailed to the main stringers. All joints in the main stringers are of the lap and screw type.

All parts are carefully crated and held together by iron straps, so that there is no danger of warping while in shipment. Each part is numbered and so packed that by following the number scheme the erection is made simple.

The framework for all systems is identical with the exception of the notching for the raw water systems. When air agitation is not required the notching is omitted.

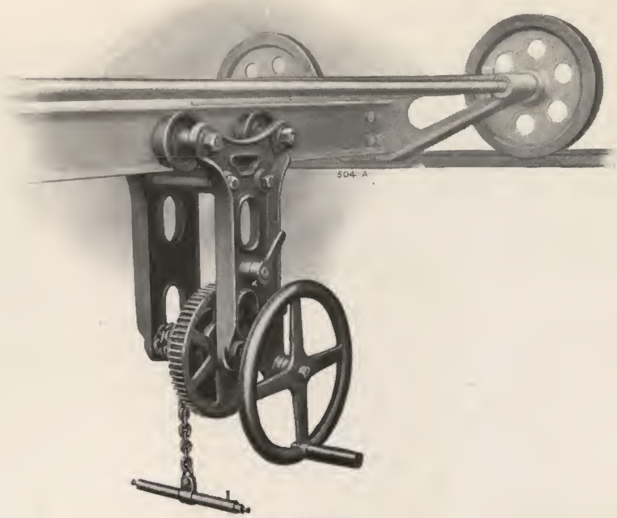
The can covers are made of two layers of 1¼" lumber laid opposite ways to prevent warping and securely fastened together with large wood screws. Lifting eye bolts or pins of galvanized iron are permanently fastened in the covers. The covers are given a coat of filler paint before shipment.

Frick standard framework and covers are made of best grade heavy selected oak unless otherwise specified at time of ordering.


## Ice Cans

The standard size ice cans used by Frick Company are given in the following table:

| Weight of Cake of Ice | Inside Dimensions | | | Length Overall | Thickness of Material—U. S. Standard Gauge | |
|---|---|---|---|---|---|---|
| | Top | Bottom | Length | | Sides | Bottom |
| 25 Lbs. | 4 x 9 | 3½ x 8½ | 23 | 24 | No. 18 | No. 18 |
| 50 Lbs. | 5 x 12 | 4½ x 11½ | 31 | 32 | No. 16 | No. 16 |
| 50 Lbs. | 6 x 10 | 5½ x 9½ | 31 | 32 | No. 16 | No. 16 |
| 50 Lbs. | 8 x 8 | 7½ x 7½ | 31 | 32 | No. 16 | No. 16 |
| 60 Lbs. / 25 Kilos. | 5 x 14 | 4½ x 13½ | 31 | 32 | No. 16 | No. 16 |
| 100 Lbs. | 8 x 16 | 7¼ x 15¼ | 31 | 32 | No. 16 | No. 16 |
| 200 Lbs. | 11½ x 22½ | 10½ x 21½ | 31 | 32 | No. 16 | No. 16 |
| 200 Lbs. | 14½ x 14½ | 13½ x 13½ | 35 | 36 | No. 16 | No. 16 |
| 300 Lbs. | 11½ x 22½ | 10½ x 21½ | 44 | 45 | No. 16 | No, 16 |
| 400 Lbs. | 11½ x 22½ | 10½ x 21½ | 57 | 58 | No. 14 | No. 14 |




Hand Hoist

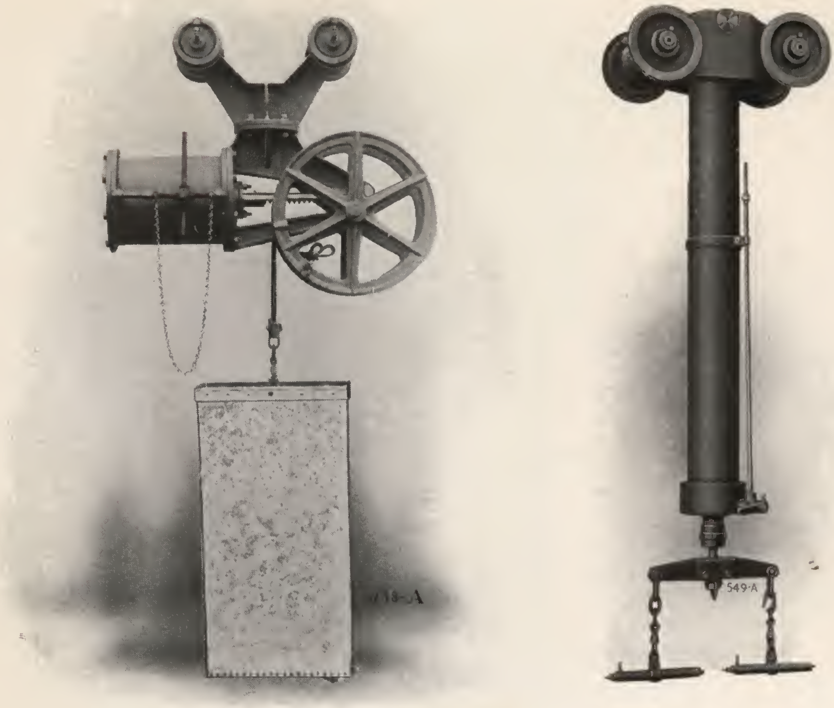
These sizes are in accordance with the standard adopted by the Ice Machinery Builders' Association of the United States some years ago.

All cans are galvanized throughout, adequately riveted, soldered and guaranteed water tight. The tops of all cans are strengthened by a band over which the sides of the cans are bent. The lifting holes are punched through the band. All ice cans sold by Frick Company are of latest standard design and construction.

## Cranes

A suitable hoisting apparatus, traveling on iron rails over each tank, is used for lifting the cans from the tank. These cranes are furnished in several types, namely, hand hoists, pneumatic hoists and electric hoists, and the choice of type will depend on the preference of the customer, as well as the local conditions under which the ice-making plant is to be operated.


Crane for Hand Hoist




Pneumatic Can Hoists

Frick crane bridges are equipped with roller bearings, and the wheels are carefully machined to insure easy travel on the rails. When necessary, the cranes are provided with squaring shafts for obtaining the proper alignment of the wheels.

All parts subjected to wear are well lubricated. Cross beams and all parts subjected to strain are liberally proportioned and will safely carry all loads met in practice. In the case of pneumatic cranes, the air used for operation is

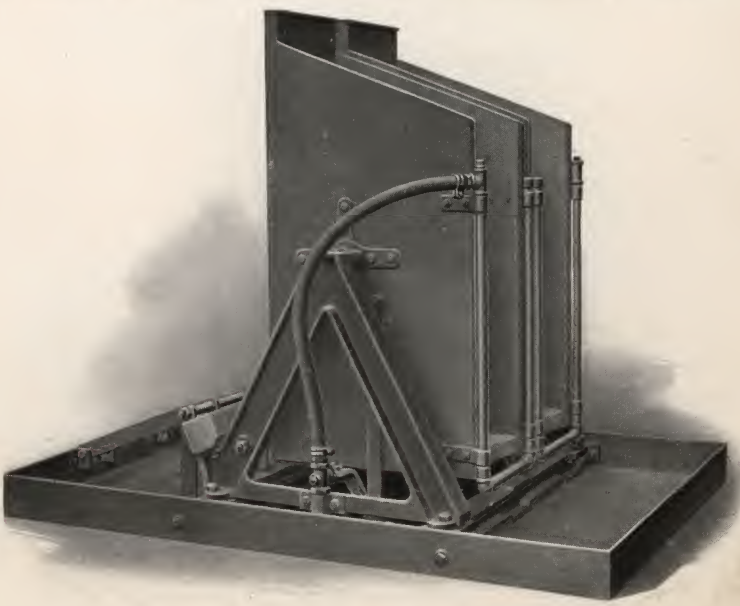
Crane for Pneumatic Hoist

led through suitable rubber hose attached to trolleys in such manner that, for all positions of the crane, the hose does not interfere with any of the work in the tank room. The choice of a suitable crane will depend on the power available and the duty required of the crane. There is a Frick crane to meet any condition.

Electric Hoist

### Can Dumps

Frick can dumps are made throughout of iron, wood lining being used only for supporting cans in the cage, and are furnished to accommodate one, two, three or more cans. They are furnished with or without sprinkler pipes for thawing the ice from the cans. The dumps are operated by hand, and in order to make this operation easy, they are mounted on trunnions, so that a very


Double Can Dump With Pan—Sprinkler Type

small force is required in dumping. The weights are so distributed that the dump automatically returns to or near its normal position after the ice has been dumped. When equipped with sprinkler pipes, the water supply is automatically cut off as soon as the dump returns to its normal position, and is automatically turned on when in a dumping position.

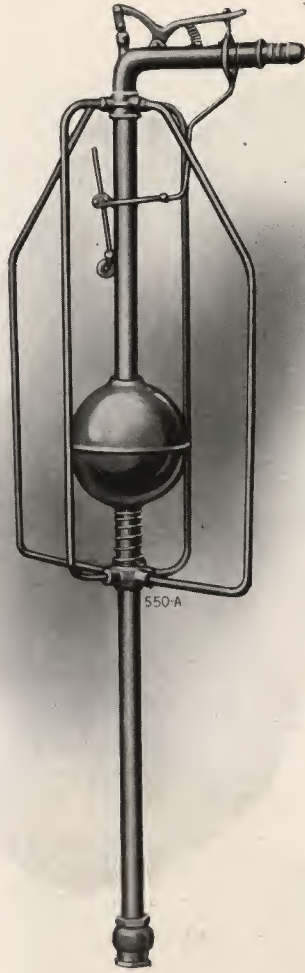
## Dip Tanks

Dip tanks for thawing the ice from the cans are often preferable to sprinkler type can dumps. Frick Company has a standard line of iron dip tanks. When these are used, can dumps without the sprinkler pipes are furnished.

## Can Fillers

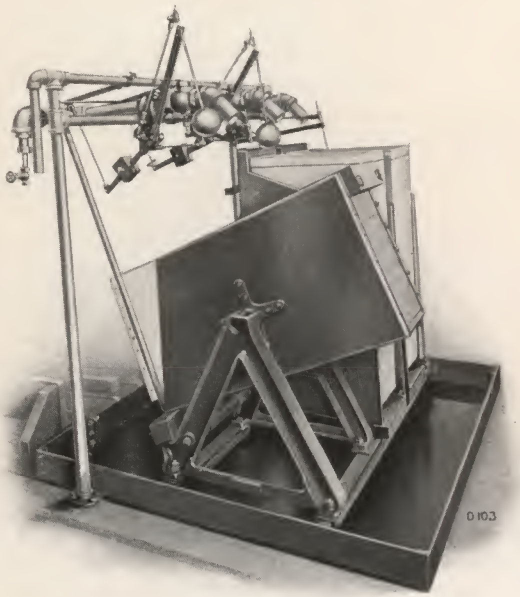
When the ice cans are refilled with water at their place in the tank, use is made of an apparatus under control of a float valve which so operates as to cut off the water supply when the water has reached a certain predetermined height in the cans. This apparatus, which is made of brass and copper, has demonstrated its reliability throughout many years of service.

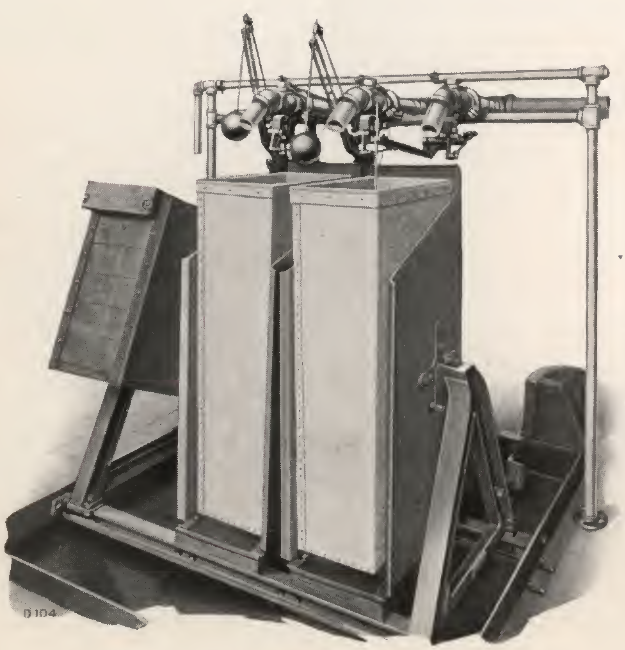
**Dip Tank**



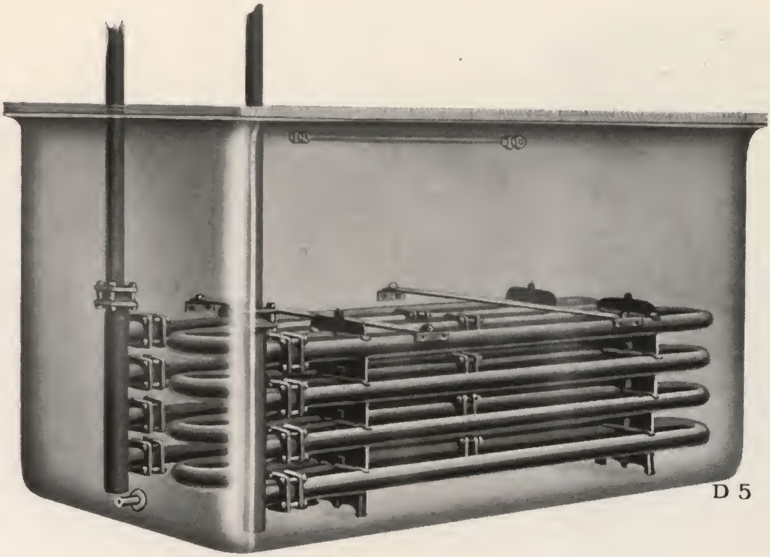

**Can Filler**

Frick Company has recently designed and placed on the market a device for filling the cans at the dump, and by its use the cans may be filled to a predetermined height in a very short time. When not in use, it automatically swings to a position where it will not interfere with the subsequent operations at the dump. This apparatus, while slightly more expensive than the former, has the advantage of permitting the cans to be refilled under better conditions and when combined with multiple hoist enables the tank man to harvest ice much faster.




**Views of Can Filling Apparatus at Dump**




Distilled Water Storage Tank—Ammonia Coil Inside

## Storage Tanks

Standard Frick ice plants are always provided with water precooling storage tanks. These tanks are of liberal size and are provided with an ample amount of ammonia cooling coils. The suction gas from the ice tanks is led through these cooling coils.

Round wooden tanks made of selected cypress and equipped with galvanized spiral cooling coils are furnished for all Frick standard raw water plants.

Iron tanks with cooling coils, as per above illustration, are usually furnished for distilled water plants.

## Filters

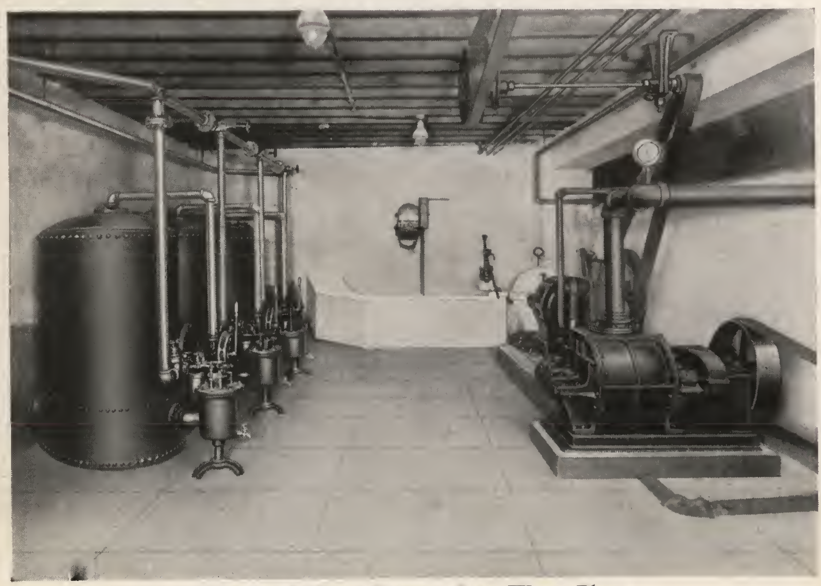
Suitable water filters are furnished as a standard part of every Frick plant.

For raw water ice plants deep sand filters are furnished with silica sand bed or similar and coagulant feeder.


Charcoal Filter

For distilled water plants charcoal filters are furnished.

The first charge of filtering material is always a part of a new filter equipment.



Filter and Blower Room—Raw Water Plant

# CHAPTER III

## RAW WATER FREEZING SYSTEMS

### Introductory

The preceding chapter covers chiefly the freezing system equipment necessary for the manufacture of opaque or white ice. When this grade of ice is satisfactory, and such is often the case as in car-icing plants and those plants furnishing large quantities of ice for commercial refrigerating purposes, no further freezing system equipment is needed.

In the majority of cases, however, the trade demands clear ice and as stated previously it is necessary to agitate the water in the ice cans during the freezing period if clear ice is to be made from raw water. This agitation is accomplished in Frick raw water plants by the use of filtered, chilled air.

Frick Company manufacture two distinct types of raw water plants, namely, the MEDIUM PRESSURE SYSTEM and the LOW PRESSURE SYSTEM. The MEDIUM PRESSURE SYSTEM is made in two types, the "CORNER TUBE TYPE" and the "CENTRAL TUBE TYPE" to meet the requirements of

**Raw Water Ice Plant**

certain sections. The type of raw water system to be used depends on local conditions. The choice should always be made by one entirely familiar with the subject, after a careful study of all conditions.

The fundamental principle underlying the operation of the raw water freezing system may be briefly stated as follows:

During the process of freezing, the constant agitation releases the air in the water as the water freezes. By this agitation the water is also greatly purified, because many of the soluble impurities in it are also released and precipitated. Furthermore, as the water is cooled its ability to hold impurities in solution is greatly decreased; consequently, most of them appear as color or visible solids in the core, which may be easily removed. After the core containing these impurities has been removed the cavity is refilled with fresh water and the block allowed to freeze solid.

Frick Company has installed a great many raw water plants, operating on this principle, which are producing good merchantable ice and the most satisfactory service.

Raw Water Freezing Tank Room

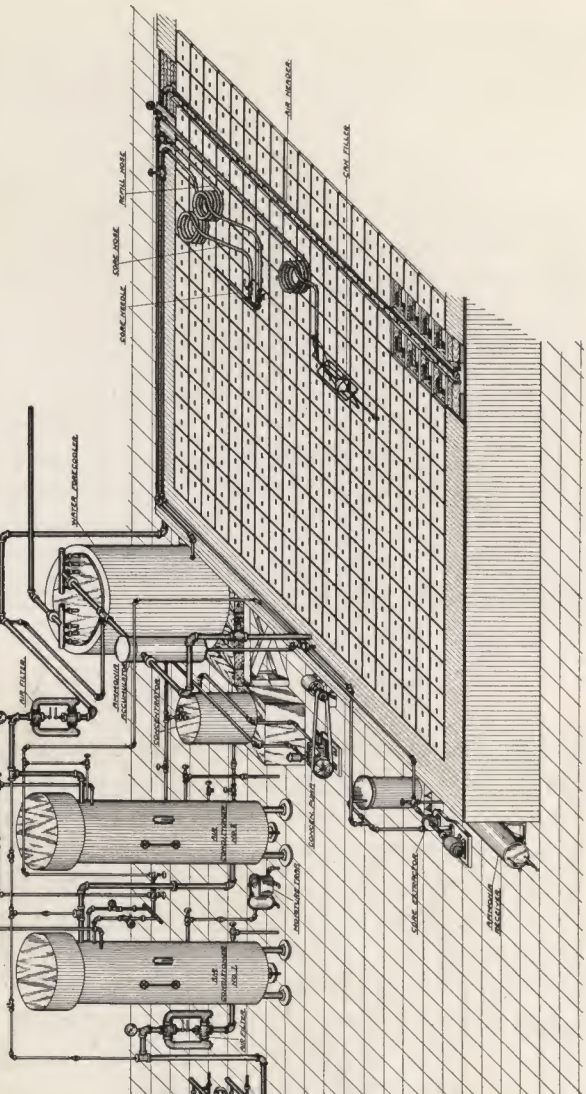
Freezing Tank Room

## The Water Supply

When the installation of a raw water freezing system is being considered, it is vitally important to have an analysis of the water and, if possible, several sample cans of ice frozen from it. The water to be analyzed should be taken from flowing supply and under such conditions as will give a reliable sample. All water is subject to change from time to time, especially where the source of supply is a flowing stream. Due to the many and varied sources from which such water is derived, there is always the possibility of it containing foreign matter either in solution or suspension.

Certain waters may contain so much mineral and foreign matter that special treatment will be necessary. In such cases any one of several types of water softening and purifying outfits made by reliable manufacturers may be applied and the water softened and purified as needed for the manufacture of ice.

The condition of the water during the period it is to be used for making ice should always be known in order to enable the selection of equipment which will produce a good grade of ice at all times.



Frick Medium Pressure Raw Water System

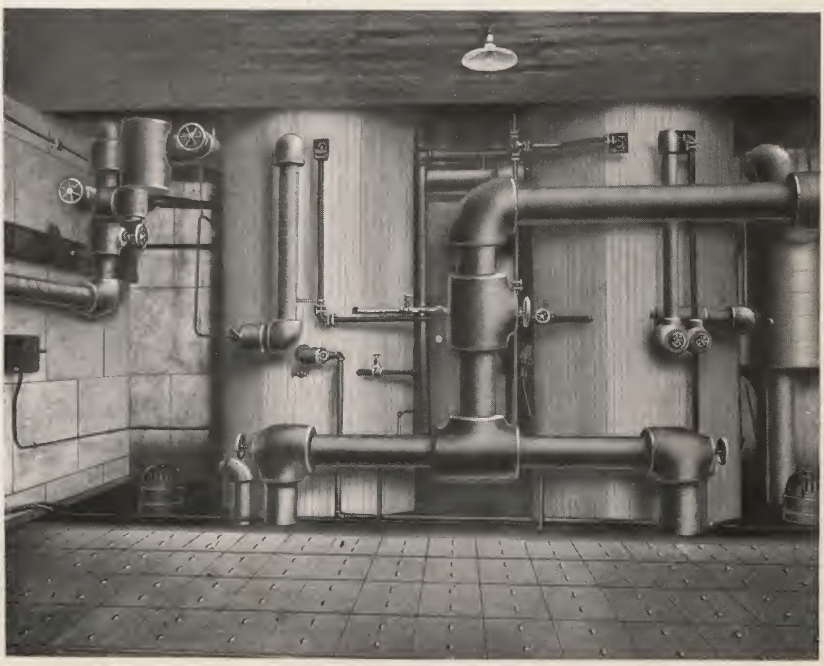
# CHAPTER IV

## FRICK MEDIUM PRESSURE RAW WATER SYSTEM

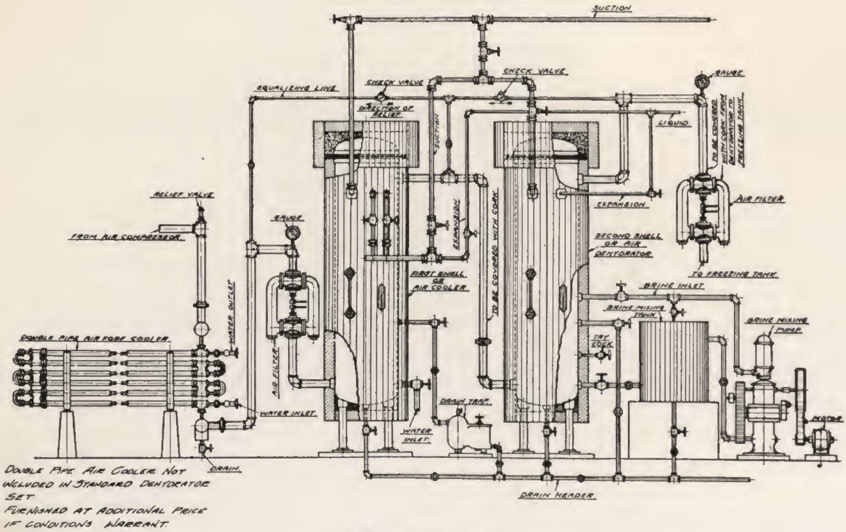
### CORNER TUBE TYPE

The arrangement of a typical installation of the Frick Medium Pressure Raw Water Freezing System is shown in the opposite illustration. The air used in this system for agitating purposes is thoroughly cleaned, cooled and dried before it reaches the ice cans. It is compressed by a suitable air compressor, the pressure used varying from 15 pounds to 30 pounds per square inch, depending on the condition of the water from which the ice is to be made and the brine temperature carried in the ice tank. The amount and kind of impurities contained in the water are also determining factors in the character of the agitation required.

The dehydrating equipment for cleaning, drying and chilling the air is the heart of any medium pressure system.



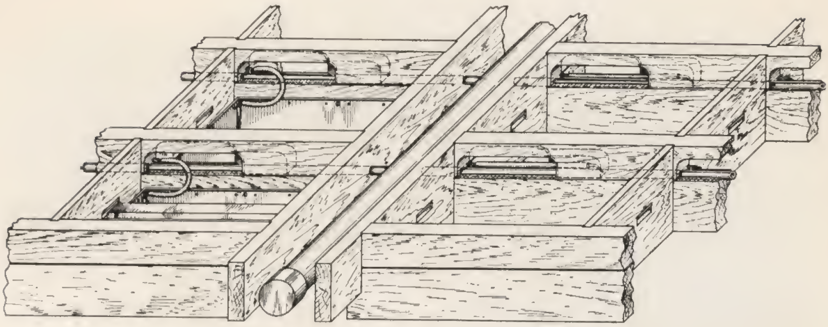
**The Dehydrators**




**Dehydrating Set**

The Frick dehydrating set is the result of eight years of painstaking experience and tests, and it performs its functions thoroughly with a minimum amount of attention.

The completeness of the dehydrating set is shown in the above diagrammatic illustration. The air from the compressor passes through a special filter into the air cooler. In the air cooler the air passes in finely subdivided streams up through cold water (which is kept clean automatically) and passes out at the top of the cooler. The air then enters the bottom of the dehydrator shell and in similar condition passes up through cold brine which thoroughly chills and dehydrates it. After leaving the dehydrator, the air passes through another special filter, which removes any remaining traces of salt or dust from it. The air filters are duplex so that one side can be cleaned while the other is in use. The small brine pump and mixing tank are provided for strengthening the brine in the dehydrator shell. This unit does not have as much moisture and dust to remove from the air as the first unit or air cooler, therefore the brine level rises very slowly and it is seldom necessary to strengthen the brine more than once each week. The air cooler and dehydrator are each provided with spiral direct expansion cooling coils. The operation of this dehydrator is very simple. No expense has been spared to make it complete and efficient. When



Detail of Framework and Air Piping

conditions warrant, a set of double pipe water fore-coolers can be added to the dehydrating set at a slight additional cost.

After this special treatment, the air is led through suitable headers to the cans. The main air header is located centrally in the wooden framework of the tank, and from this main header, small headers arranged in grooves in the framework pass transversely between each row of cans. To these headers the fittings shown are attached in such manner that the air may pass freely through the rubber air tubes to the brass tubes in the cans. All air headers and laterals in the framework are made of galvanized pipe.

The framework of the freezing tank is so designed that the rubber air hose when not in use may be placed in the slot provided for this purpose. This feature, as illustrated above, affords an extremely simple and convenient method of disposing of the hose when the ice is ready for harvesting.

A detail of the tube in the corner of the can is shown above. The brass tube extends from the top to the bottom of the can. The lower end of the tube is filled with a solid brass rod about 4″ long and the air leaves the tube at the V notch shown. A hard brass head is brazed to the top of the tube. This head is machined so that the air fitting makes a neat tapered fit in it. The tube is solidly floated into the corner of the can with solder at the time the can is made and is therefore practically integral with the can.

Showing Connection to Corner Tube

## Harvesting

The air is left on the cans until the ice is frozen solid, the fitting then disconnected and flipped into the pocket in the framework, and the ice harvested just as distilled water or opaque ice. Since the air tube is integral with the can, there is no time lost in handling air tubes and the tubes cannot be damaged.

In medium size and large plants, Frick Company recommends the use of multiple can hoists, dip tanks and can dumps—either two, three, four, or six cans may be handled at one time according to the size of the tanks. The improved can filling device at the dump is also recommended, and of course an electric hoist. After the ice is dumped, less than a minute is required to fill the cans. The filled cans are then carried by the crane to their cells, lowered into the tank, and the air fitting inserted in the corner tube—a very simple and easy operation. The maximum amount is thus harvested with minimum labor.

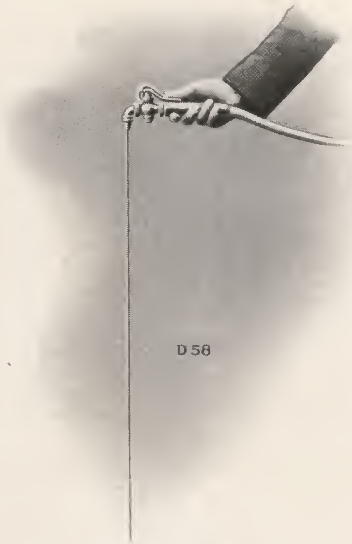
### Core Pumping

Clear, merchantable ice is made with the Frick Medium Pressure System without pumping cores when the water is good, since the agitation continues to the end. If the water contains salts which precipitate in the cores as carbonates, and no purifying treatment is applied it will of course be necessary to remove cores and refill same as in any freezing system. The same apparatus is used for this as for the low pressure system, and it is explained in detail under the low pressure drop pipe system.

## MEDIUM PRESSURE CENTRAL TUBE SYSTEM

In some localities a central tube suspended in the middle of the can is preferred to the tube in the corner construction for medium pressure air. To meet this preference Frick Company has developed the Frick Central Tube Medium Pressure System. This system is identical with the tube in the corner system in all respects except the arrangement of the tube in the ice can and the air fitting for connecting to the tube in the can. In other words, the same dehydrating system is used, air is used at the same pressure, and the air is left on the ice cans until the blocks are frozen solid. This

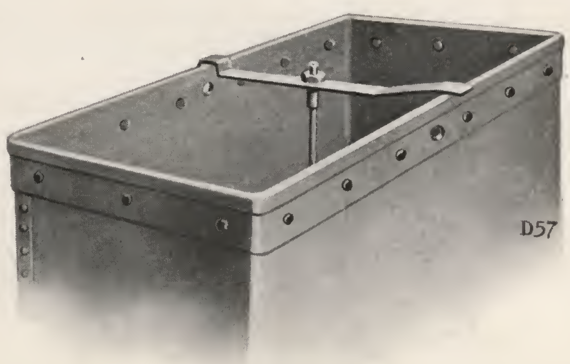
Frick Medium Pressure Raw Water Ice




Thawing Needle

being the case, since the tubes freeze into the center of the ice blocks, they must be taken out. A special thawing needle is provided for this purpose.

The special thawing needle for removing the air tubes from the ice is shown above. Warm water from the ammonia condensers is used for this purpose and only a few moments are required to thaw the tubes loose.




Center Tube Support


**Inserting Thawing Needle in Tube**

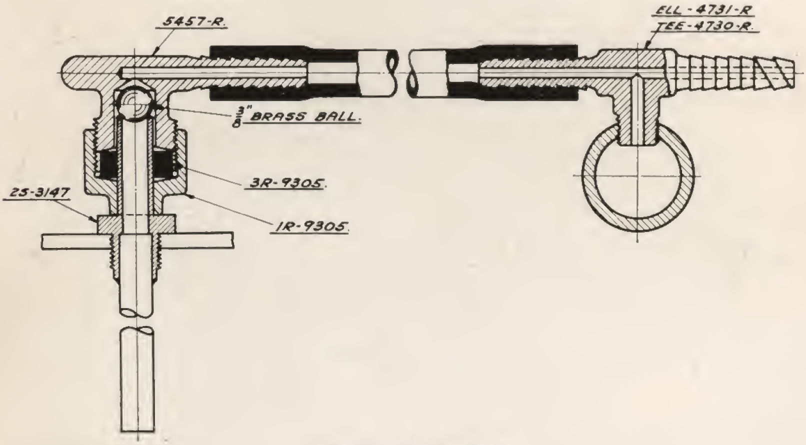
The illustration on opposite page shows the method used to support the brass central tube. The support bars are made of galvanized iron and are fastened to the central tubes as shown.

A special adjustable air fitting is used for making the connection to the air tube. The illustration on page 44 shows clearly the construction of this fitting and the method of connection.

## Harvesting

The usual method of harvesting the ice with this system is as follows: The air is left on the cans until the ice is frozen solid; the air fitting is disconnected from the central tube and flipped into the pocket provided in the framework; the cans are taken from the ice tank and carried by the crane to the

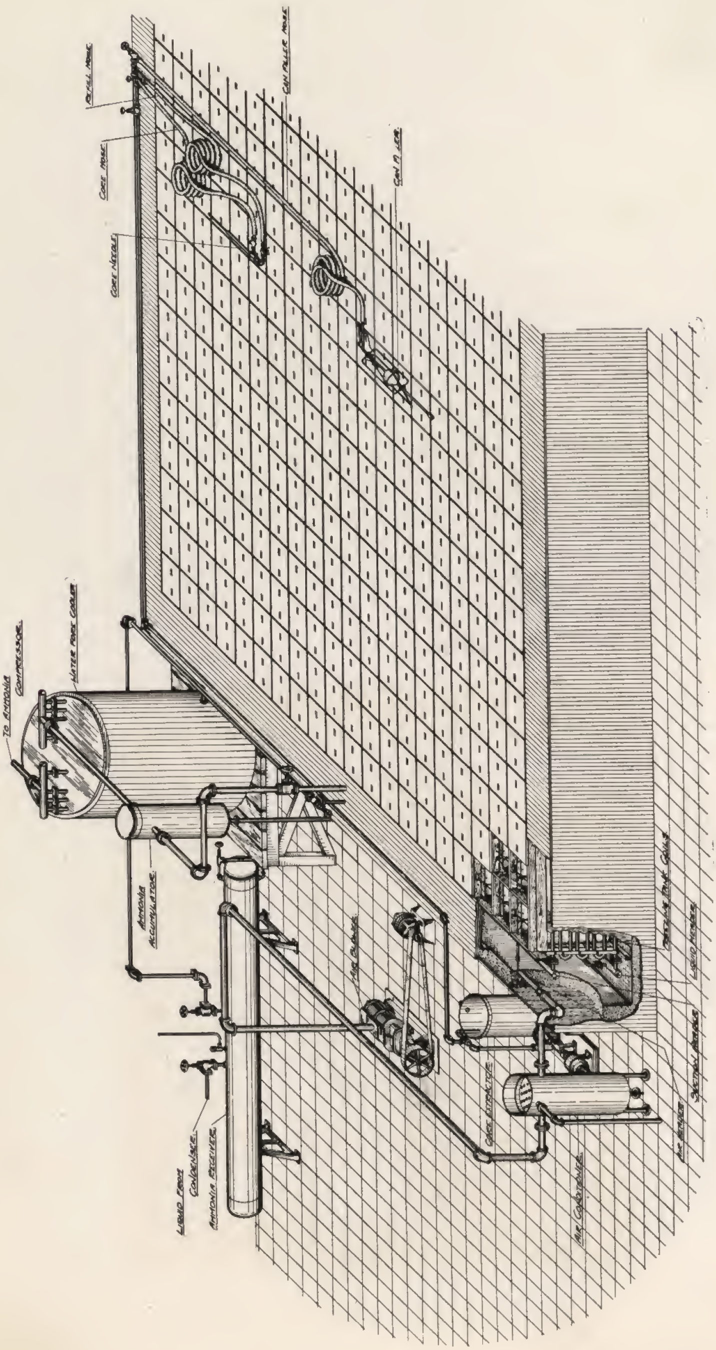
dip tank; the cans are lowered into the dip tank, then raised partially and the air tubes removed by means of the thawing needle and placed in a suitable rack provided; the cans are then raised from the dip tank, placed in the can dump and the ice dumped; next, the cans are refilled while in the dump and the air tubes put in place; and then the filled cans are carried back to their tank cells, lowered into the tank, and the air fitting connected. The simplicity of the harvesting is readily seen.




**Detail of Air Fitting**

Several cans are harvested at the same time, according to the size of the plant, as explained before. The paragraph on page 41 regarding core pumping applies also to the central tube medium pressure system.

Ice Storage—Raw Water Ice Plant



Frick Low Pressure Raw Water System

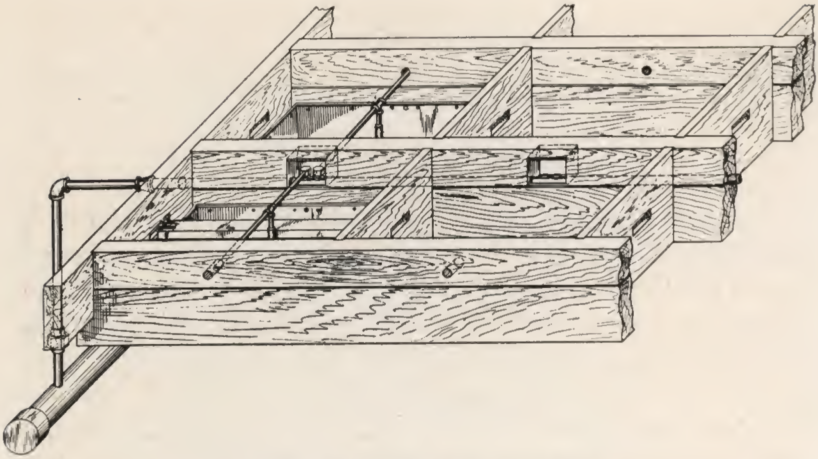
# CHAPTER V

## FRICK LOW PRESSURE RAW WATER SYSTEM

### General Description

The arrangement of a typical installation of the Frick Low Pressure Raw Water System is shown on the opposite page. This system is particularly adapted to the freezing of relatively pure water and for use in the smaller size plants. The first cost as well as the power cost for operation is less for this system than for the medium pressure systems. However, the harvesting cost is greater, especially in large plants, and the ice produced always has a thin, white core, unless the cores should be filled with distilled water. These thin, white cores are not objectionable in many localities. The illustration below shows excellently the quality of the ice made with this system.

Frick Low Pressure System Raw Water Ice



Detail of Framework and Air Piping

The air used is compressed to a pressure of two to three pounds by an ordinary rotary, low pressure, air blower. The air is cooled before entering the cans by being passed through a shell and tube water-cooled air conditioner.

The main air header extends along one end of the freezing tank, and secondary headers extend from it to the other end of the freezing tank. These headers are arranged in grooves in the framework, one between each alternate row of cans and are equipped at each can with a special air valve which closes automatically when not in use. The end of the support pipe for the drop pipe is fitted with a ball shaped fitting which rests on the air valve. When the drop pipe is placed in the can this ball fitting opens the air valve and is kept in place by its own weight.

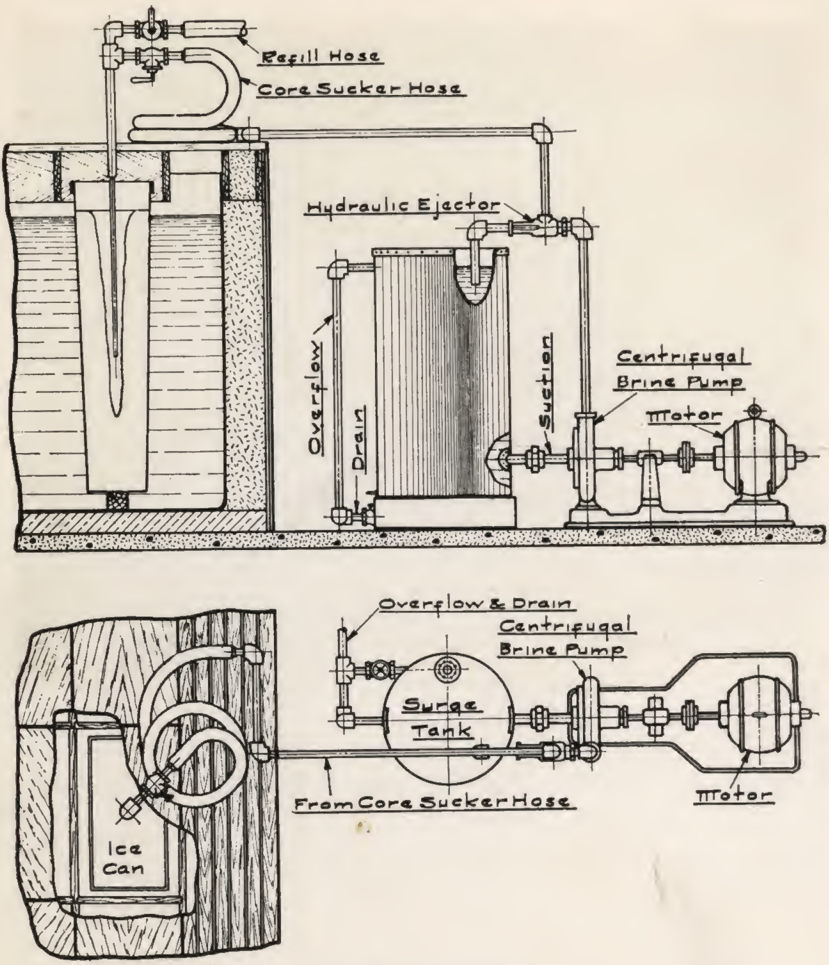
All fittings and pipes in Frick Raw Water Freezing Systems subjected to the possibility of rusting are either made of brass or are heavily galvanized. This feature not only increases the useful life of the pipes and fittings but eliminates all possibility of the water becoming contaminated by absorbing impurities resulting from corrosion of the piping.

Raw Water Freezing Tank Room

## Core Sucking and Refilling

After the block of ice is frozen nearly solid (the quality of the water, of course, determines this point) the impurities which have been concentrated at the center of the block are removed by pumping out the core and refilling it with fresh water from the water storage tank. The air agitation is left on until just before the ice freezes up to the end of the drop pipe. The drop pipe is then removed and hung on proper rack along the side of the tank. The core pumping outfit with hose connections is shown clearly in the illustration on page 50.

The core is sucked by means of a centrifugal pump discharging through a hydraulic ejector. This arrangement keeps the pump full of water at all times and permits the use of a standard type of pump with direct connected motor.




Core Pumping Outfit

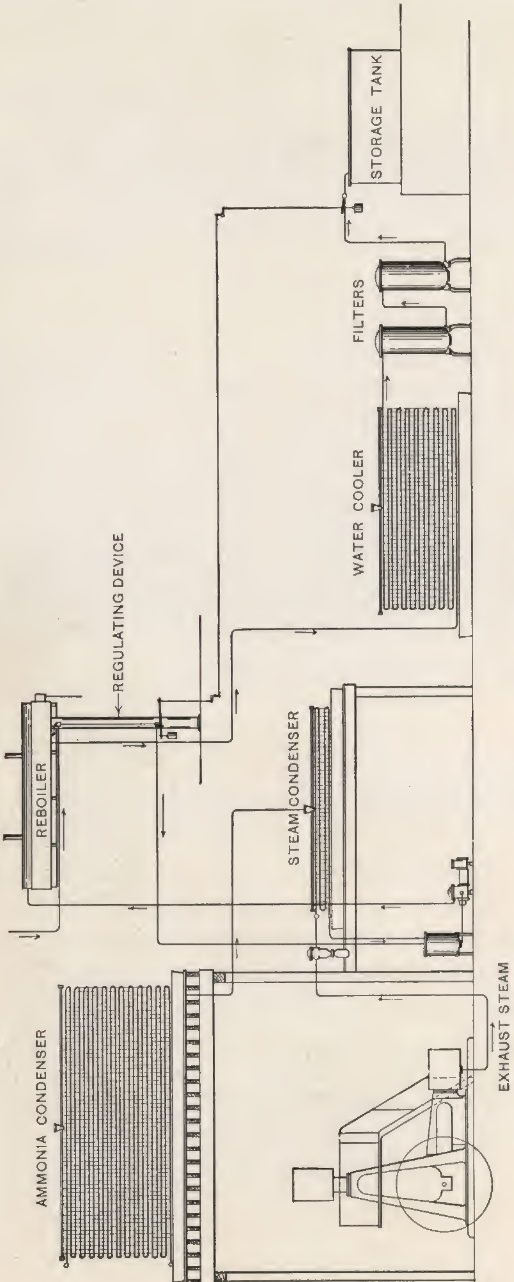
When the ice has frozen to the proper point for the removal of cores, the core sucking and refilling needle is inserted into the core. Opening one valve removes the core and opening the other fills it. The apparatus is extremely simple and easy to operate. It eliminates all core pump troubles.

Freezing Tanks—Raw Water System

## Harvesting

After the cores have been pumped out and refilled and the drop pipes removed as explained in the preceding paragraph, the ice is permitted to freeze solid. It is then harvested, one or more cans at a time, depending on the size of the plant and type of crane used, in the regular manner. The ice cans can be filled at the dump if desirable or if it is preferable to fill them at their places in the tank the can filler is equipped with a special air connection for producing agitation during the filling period. The air hose in the latter case is placed inside of the main can filler hose which is made of proper size to suit this construction.

The simplicity of the Frick Low Pressure System speaks for itself. The air equipment is practically automatic and requires very little attention. The system is giving excellent results everywhere.




**Improved Frick Distilling System**

# CHAPTER VI

## DISTILLED WATER FREEZING SYSTEM EQUIPMENT

### Distilling System

In some localities, after all conditions are considered, the distilled water plant is found to be the type best suited. Frick distilled water plants hardly need an introduction, since they have been the standard type throughout the past forty years. In order to manufacture good distilled water ice, the equipment described in this chapter is required in addition to that described in Chapter II.

On the opposite page is shown a diagrammatic arrangement of the Frick Distilling System. The function of the distilling system is to take the exhaust steam from the plant machinery and convert it into pure distilled water for ice making. The path of the steam can be readily followed from the refrigerating machine through the oil separator to the steam condenser; thence to the float tank and pump; then to the reboiler, where any oil is removed and air also; and then through the water coolers and charcoal filters to the distilled water storage tank from which it is taken to the ice cans. This system thoroughly separates the oil and impurities from the exhaust steam and the distilled water it produces is guaranteed to make good, merchantable ice.

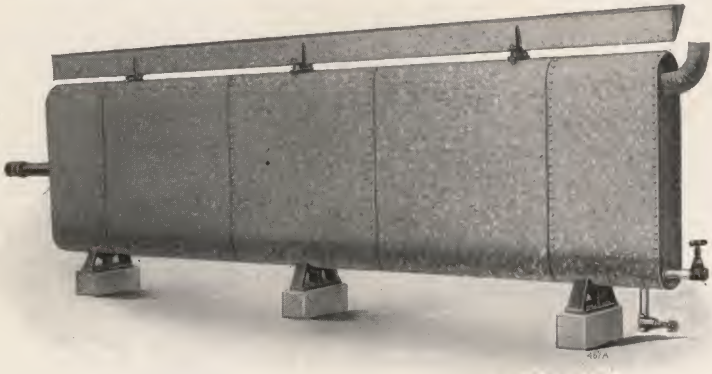
Oil Separator

### Exhaust Steam Oil Separators

The oil separator is an important part of the distilling system. Frick separators are of best welded construction throughout and built with an efficient baffle. They are furnished complete with suitable stands, or provision for hanging, oil gauge glass and companion flanges.

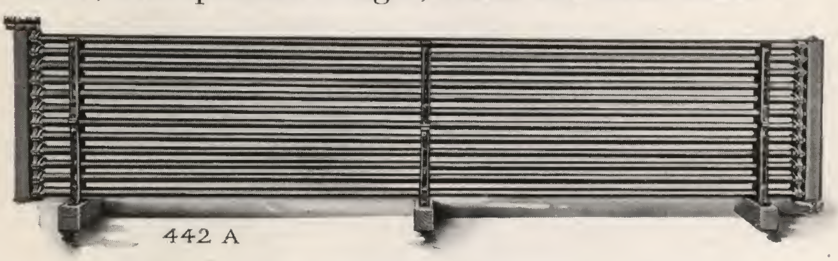
## Steam Condenser

These are manufactured in several types: The shell type, the atmospheric flat coil and the submerged coil type.



**Flask Steam Condenser**

The shell type is the most popular. These condensers are arranged in batteries as shown above, and are made of No. 10 galvanized iron. The condensing surface is liberally proportioned. These condensers are furnished complete, as shown, with sprinkler troughs, stands and steam header.




**Atmospheric Steam Condenser**

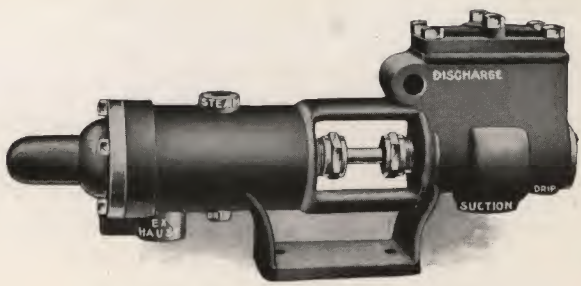
The atmospheric flat coil condensers are of the above construction and are made of 2″ standard galvanized pipe and galvanized cast iron headers. These headers are of special construction and are easily removed for cleaning. The condenser is furnished complete with stands, sprinkler troughs and steam header for the proper number of coils.

The submerged coil type consists of properly proportioned tank with submerged pipe coils and is used in cases where the water conditions will not permit of the use of the atmospheric types.


Float Tank

## Distilled Water Pump and Float Tank

The Frick float tank is clearly shown above. These tanks are furnished in two standard sizes.




Distilled Water Pump

Steam driven distilled water pumps are used in any capacity.

## Reboiler


**Reboiler**

The Frick reboiler is the result of long experience in reboiling, skimming and clarifying distilled water. It consists of the heavy rectangular tank shown, with hood made in sections to permit of easy removal, the special steam heating coil of ample surface, the regulating valve and the skimming bowl. The distilled water enters at the skimming end and is withdrawn from the opposite end at the bottom of the tank, thus insuring a thorough treatment of the water.

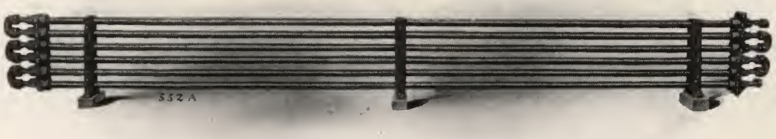

**Distilled Water Regulator**

## Distilled Water Regulator

It is often possible to arrange the distilling system on a gravity system so that the condensed steam or condensate flows by gravity from the steam condenser to the reboiler and on to the storage tank. When this arrangement is possible it is very desirable. In order to properly regulate the skimming of the reboiler

and the flow of the distilled water from it when this gravity system is used, Frick Company has designed the distilled water regulator shown opposite. This is an extremely simple and satisfactory device. It is connected into the distilled water line to the storage tank and is usually mounted on the side of the storage tank.

## Distilled Water Cooler

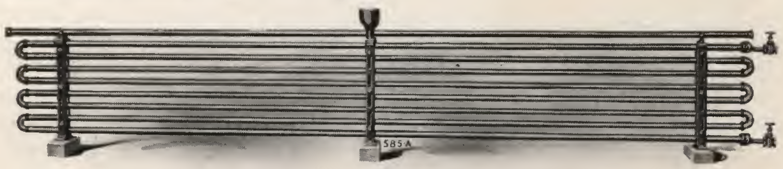


Double Pipe Distilled Water Cooler

In order to reduce the temperature of the distilled water as much as possible, it is passed through a water cooled flat galvanized cooler before it enters the storage tank. These are built in both the double pipe and atmospheric pipe styles.

The above style is made of 1¼″ and 2″ selected galvanized pipe and galvanized fittings.

The atmospheric style is made of 2″ selected galvanized pipe and galvanized fittings.

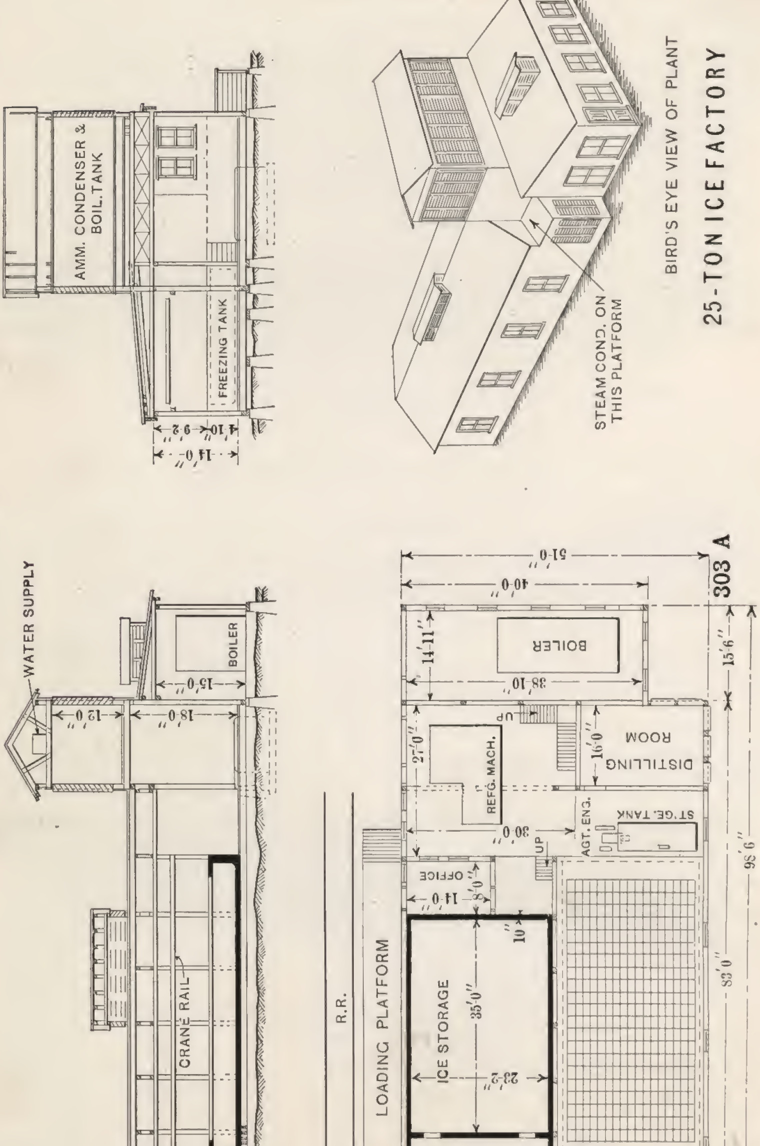


Atmospheric Distilled Water Cooler

Each style is furnished complete as shown. Water headers are supplied if ordered, when several coils are required.

## Distilled Water Pipe Connections

The necessary pipe and fittings for the distilled water pipe connections are always furnished galvanized throughout. This keeps the distilled water free from rust and adds to the life of the piping.




BIRD'S EYE VIEW OF PLANT

25-TON ICE FACTORY

303 A

# CHAPTER VII

## CONCLUSION

### Expense of Manufacture

Most of the operating expenses of an ice plant can be predetermined, as all expenses connected with the operation of the factory are practically fixed quantities for given rates of production. Ice making is in every sense a routine business with no greater contingencies than the business of pumping a given quantity of water, and just as susceptible of exact calculation. The more extensive or larger the plant, the less the cost per ton of the ice made, but even the smallest ice plants prove remunerative investments in most localities.

In addition to the influence of the capacity of a plant, the cost of making ice varies in different localities due to variations in fuel or power and labor costs. The relative difference, however, usually fits the locality, and ice is manufactured and sold at retail the country over. The operating costs of the ice factory consist of the fuel or power cost; light, oil and waste; slight loss of salt and ammonia; sundry small repairs; salary of superintendent and engineer, and wages of firemen, tankmen and other labor which, of course, depends on the plant size. Added to these are the annual depreciation and upkeep.

### Establishing an Ice Factory

The first and most important thing is to have a market for the ice. While the home or local demand may not always be sufficient to justify entering the business, the factory may be so located that it will serve as a center of supply for outlying towns easily reached by railroad, truck or wagon deliveries, and thus warrant the factory. Again, past experience has proven that the demand for ice grows larger every year, and that the introduction of first-class manufactured ice in a locality is simply the beginning of a constantly increasing and substantial demand.

Raw Water Ice Plant

In planning for an ice factory, another very important consideration is the water supply. A reliable and ample supply of water should be available at all times and all seasons. Three to five gallons of water per minute will be required for every ton of ice-making capacity, depending on the temperature of the water and the type of equipment used. Of course, this quantity can be greatly reduced by the use of a water-cooling tower for the condenser water and a constant recirculation.

## Ice Factory Buildings

Ice factory buildings are usually of very simple construction and can be built of wood, brick, concrete or any suitable building material, depending upon the local building and fire regulations, the taste of the owner, and the capital to be invested. Well built buildings are always a good investment. The ice factory should be divided into several parts: The boiler room, if a steam plant, should be fireproof; the engine or compressor room, the ice tank room, the ice storage house with ante-room, and the business office. See the typical plant layouts on pages 58 and 62.

## Ice Tank Insulation

In order to obtain economical ice manufacture it is necessary to properly insulate the ice and water tanks. Cheap insulating materials may give fair results for a few years,

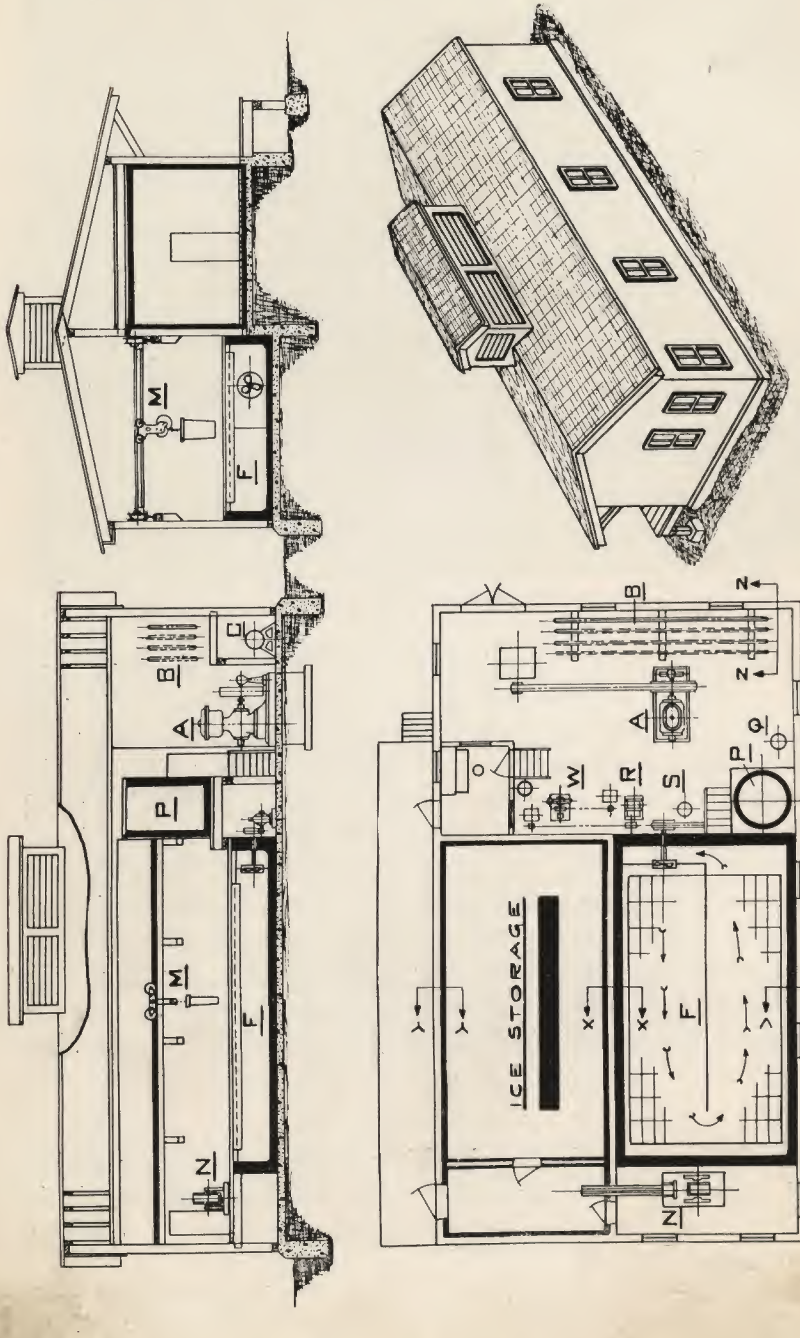
Raw Water Freezing Tank Room

but they soon begin to deteriorate and after a short time in service become practically worthless as insulation. For this reason Frick Company recommends the use of only the very best insulating materials. The bottom of the tanks should be insulated with two layers of cork board of five inches total thickness and the sides and ends of the tanks with at least ten inches of granulated cork held in place by a double tongue and groove board curbing. The bottom insulation should be laid in hot pitch and on a concrete foundation. This insulation will last as long as the tanks and will retain its efficiency to the end when properly installed. Other durable types of good heat resisting insulation may also be used.

## Guarantees

Frick Company's Ice Making Systems afford the ice plant owner a system suitable for any condition under which ice can be satisfactorily made of good merchantable quality at a minimum cost.

Frick Company guarantees both its Raw Water and Distilled Water Ice-making Systems described in this booklet.




Typical Arrangement of Small Raw Water Ice Plant
(See Opposite Page for Legend and Dimensions)

## LEGEND

A—Refrigerating Machine
B—Ammonia Condenser
C—Ammonia Receiver
F—Freezing Tank
M—Ice Crane and Hoist
N—Can Dump
P—Storage Tank
Q—Filters
R—Air Blower
S—Air Cooler
W—Core Pump

## APPROXIMATE DIMENSIONS OF 1 TO 25-TON ICE FACTORIES

| Capacity Tons Ice | MACHINE ROOM | | | TANK ROOM | | | ICE STORAGE | | | SIZE BLDG. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Length | Width | Height | Length | Width | Height | Length | Width | Height | Length | Width |
| 1 | 19′–0″ | 14′–0″ | 14′–0″ | 19′–5″ | 8′–9″ | 14′–0″ | 11′–5″ | 9′–1″ | 8′–0″ | 35′–0″ | 20′–6″ |
| 2 | 22′–0″ | 15′–0″ | 14′–0″ | 23′–6″ | 9′–11″ | 14′–0″ | 15′–6″ | 10′–11″ | 8′–0″ | 40′–0″ | 23′–6″ |
| 3 | 26′–0″ | 15′–0″ | 14′–0″ | 23′–6″ | 12′–4″ | 14′–0″ | 15′–6″ | 12′–6″ | 8′–0″ | 40′–0″ | 27′–6″ |
| 5 | 29′–0″ | 16′–0″ | 14′–0″ | 28′–0″ | 14′–10″ | 14′–0″ | 20′–0″ | 13′–0″ | 8′–0″ | 45′–6″ | 30′–6″ |
| 8 | 31′–0″ | 18′–0″ | 14′–0″ | 36′–0″ | 14′–10″ | 14′–0″ | 28′–0″ | 15′–0″ | 8′–0″ | 55′–6″ | 32′–6″ |
| 10 | 33′–0″ | 18′–0″ | 15′–0″ | 36′–0″ | 17′–2″ | 15′–0″ | 29′–0″ | 14′–8″ | 9′–0″ | 55′–6″ | 34′–6″ |
| 12 | 33′–0″ | 18′–0″ | 15′–0″ | 41′–0″ | 17′–2″ | 15′–0″ | 33′–0″ | 14′–8″ | 9′–0″ | 60′–6″ | 34′–6″ |
| 15 | 36′–0″ | 20′–0″ | 15′–0″ | 43′–0″ | 19′–8″ | 15′–0″ | 35′–0″ | 15′–2″ | 9′–0″ | 64′–6″ | 37′–6″ |
| 20 | 39′–0″ | 20′–0″ | 15′–0″ | 50′–0″ | 20′–10″ | 15′–0″ | 42′–0″ | 17′–0″ | 9′–0″ | 71′–6″ | 40′–6″ |
| 25 | 42′–0″ | 22′–0″ | 15′–0″ | 55′–0″ | 23′–4″ | 15′–0″ | 47′–0″ | 17′–6″ | 9′–0″ | 78′–6″ | 43′–6″ |

## PROPERTIES OF SATURATED AMMONIA—MACINTIRE

**By Permission of Ice Trade Journal**

| TEMPERATURE | | PRESSURE IN POUNDS PER SQUARE INCH | | SATURATED VAPOR | | LIQUID | | |
|---|---|---|---|---|---|---|---|---|
| Deg. Fah. | Deg. Abso. | Absolute | Gauge | Volume Cu. Ft. per Pound | Weight Pounds per Cu. Ft. | Weight Pounds per Cu. Ft. | Total Lat. Heat B. T. U. per Pound | Spec. Heat of Saturated Vapor |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| —40 | 420 | 9.25 | —5.45 | 28.060 | .0356 | 45.74 | 597.30 | 0.505 |
| —35 | 425 | 11.10 | —3.60 | 23.590 | .0425 | 45.21 | 594.06 | 0.507 |
| —30 | 430 | 13.32 | —1.38 | 19.830 | .0505 | 44.78 | 590.73 | 0.510 |
| —25 | 435 | 15.50 | 0.70 | 17.190 | .0582 | 44.35 | 587.39 | 0.511 |
| —20 | 440 | 17.91 | 3.21 | 15.000 | .0667 | 43.92 | 584.31 | 0.514 |
| —18 | 442 | 18.92 | 4.22 | 14.240 | .0702 | 43.75 | 582.67 | 0.515 |
| —16 | 444 | 19.97 | 5.27 | 13.530 | .0739 | 43.58 | 581.30 | 0.516 |
| —14 | 446 | 21.06 | 6.36 | 12.860 | .0777 | 43.41 | 579.92 | 0.517 |
| —12 | 448 | 22.19 | 7.49 | 12.240 | .0817 | 43.24 | 578.52 | 0.518 |
| —10 | 450 | 23.36 | 8.66 | 11.660 | .0857 | 43.07 | 577.13 | 0.520 |
| — 9 | 451 | 23.96 | 9.26 | 11.380 | .0878 | 42.99 | 576.40 | 0.520 |
| — 8 | 452 | 24.58 | 9.88 | 11.110 | .0900 | 42.91 | 575.69 | 0.521 |
| — 7 | 453 | 25.21 | 10.51 | 10.850 | .0922 | 42.83 | 574.97 | 0.521 |
| — 6 | 454 | 25.85 | 11.15 | 10.600 | .0944 | 42.75 | 574.26 | 0.522 |
| — 5 | 455 | 26.50 | 11.80 | 10.350 | .0966 | 42.67 | 573.54 | 0.522 |
| — 4 | 456 | 27.16 | 12.46 | 10.110 | .0989 | 42.58 | 572.81 | 0.523 |
| — 3 | 457 | 27.84 | 13.14 | 9.878 | .1012 | 42.50 | 572.09 | 0.524 |
| — 2 | 458 | 28.54 | 13.84 | 9.654 | .1036 | 42.42 | 571.36 | 0.524 |
| — 1 | 459 | 29.26 | 14.56 | 9.446 | .1060 | 42.34 | 570.62 | 0.525 |
| 0 | 460 | 29.99 | 15.29 | 9.223 | .1084 | 42.26 | 569.89 | 0.526 |
| 1 | 461 | 30.74 | 16.04 | 9.015 | .1109 | 42.18 | 569.15 | 0.526 |
| 2 | 462 | 31.50 | 16.80 | 8.812 | .1134 | 42.10 | 568.40 | 0.527 |
| 3 | 463 | 32.27 | 17.57 | 8.614 | .1160 | 42.02 | 567.66 | 0.528 |
| 4 | 464 | 33.06 | 18.36 | 8.421 | .1187 | 41.95 | 566.91 | 0.528 |
| 5 | 465 | 33.86 | 19.16 | 8.233 | .1214 | 41.87 | 566.15 | 0.529 |
| 6 | 466 | 34.67 | 19.97 | 8.051 | .1241 | 41.79 | 565.40 | 0.530 |
| 7 | 467 | 35.49 | 20.79 | 7.874 | .1269 | 41.71 | 564.64 | 0.530 |
| 8 | 468 | 36.33 | 21.63 | 7.702 | .1297 | 41.64 | 563.88 | 0.531 |
| 9 | 469 | 37.18 | 22.48 | 7.535 | .1326 | 41.56 | 563.11 | 0.532 |
| 10 | 470 | 38.05 | 23.35 | 7.372 | .1356 | 41.48 | 562.35 | 0.532 |
| 12 | 472 | 39.83 | 25.13 | 7.058 | .1416 | 41.34 | 560.80 | 0.534 |
| 14 | 474 | 41.68 | 26.98 | 6.759 | .1479 | 41.18 | 559.24 | 0.535 |
| 16 | 476 | 43.60 | 28.90 | 6.476 | .1543 | 41.03 | 557.67 | 0.537 |
| 18 | 478 | 45.60 | 30.90 | 6.208 | .1610 | 40.88 | 556.08 | 0.538 |
| 20 | 480 | 47.68 | 32.98 | 5.953 | .1699 | 40.73 | 554.49 | 0.540 |
| 22 | 482 | 49.83 | 35.13 | 5.709 | .1751 | 40.59 | 552.87 | 0.541 |
| 24 | 484 | 52.05 | 37.35 | 5.475 | .1825 | 40.44 | 551.26 | 0.543 |
| 26 | 486 | 54.35 | 39.65 | 5.255 | .1902 | 40.30 | 549.60 | 0.544 |
| 30 | 490 | 59.19 | 44.49 | 4.847 | .2063 | 40.01 | 546.28 | 0.547 |
| 35 | 495 | 65.70 | 51.00 | 4.385 | .2281 | 39.66 | 542.03 | 0.552 |
| 40 | 500 | 72.77 | 58.07 | 3.976 | .2515 | 39.31 | 537.69 | 0.556 |
| 45 | 505 | 80.45 | 65.75 | 3.612 | .2768 | 38.98 | 533.26 | 0.561 |
| 50 | 510 | 88.76 | 74.06 | 3.287 | .3042 | 38.64 | 528.73 | 0.565 |
| 55 | 515 | 97.64 | 82.94 | 2.996 | .3338 | 38.31 | 524.10 | 0.570 |
| 60 | 520 | 107.20 | 92.50 | 2.734 | .3658 | 37.99 | 519.37 | 0.575 |
| 65 | 525 | 117.59 | 102.89 | 2.499 | .4002 | 37.67 | 514.56 | 0.580 |
| 70 | 530 | 128.72 | 114.02 | 2.288 | .4372 | 37.36 | 509.63 | 0.586 |
| 75 | 535 | 140.57 | 125.87 | 2.097 | .4768 | 37.03 | 504.59 | 0.592 |
| 78 | 538 | 148.04 | 133.34 | 1.992 | .5020 | 36.86 | 501.51 | 0.595 |
| 80 | 540 | 153.19 | 138.49 | 1.926 | .5193 | 36.74 | 499.45 | 0.598 |
| 82 | 542 | 158.49 | 143.79 | 1.862 | .5370 | 36.62 | 497.36 | 0.600 |
| 84 | 544 | 163.93 | 149.23 | 1.801 | .5551 | 36.50 | 495.26 | 0.602 |
| 86 | 546 | 169.50 | 154.80 | 1.743 | .5737 | 36.39 | 493.15 | 0.605 |
| 88 | 548 | 175.22 | 160.52 | 1.686 | .5928 | 36.27 | 491.01 | 0.607 |
| 90 | 550 | 181.08 | 166.38 | 1.633 | .6123 | 36.15 | 488.86 | 0.610 |
| 92 | 552 | 187.09 | 172.39 | 1.581 | .6323 | 36.04 | 486.69 | 0.612 |
| 94 | 554 | 193.20 | 178.50 | 1.532 | .6529 | 35.92 | 484.51 | 0.615 |
| 96 | 556 | 199.59 | 184.89 | 1.484 | .6741 | 35.81 | 482.31 | 0.617 |
| 98 | 558 | 206.09 | 191.39 | 1.437 | .6959 | 35.70 | 480.87 | 0.620 |
| 100 | 560 | 212.75 | 198.05 | 1.392 | .7183 | 35.58 | 477.85 | 0.623 |
| 105 | 565 | 229.50 | 214.80 | 1.297 | .7700 | 35.28 | 472.31 | 0.630 |
| 110 | 570 | 246.00 | 231.3 | 1.205 | .830 | 34.98 | 466.62 | 0.638 |
| 115 | 575 | 264.40 | 249.7 | 1.118 | .895 | 34.74 | 460.90 | 0.642 |
| 120 | 580 | 285.10 | 270.4 | 1.033 | .968 | 34.43 | 453.86 | 0.650 |

## PROPERTIES OF SATURATED STEAM

| Gauge Press Lbs. per Sq. Inch | Absolute Pressure Lbs. per Sq. Inch. | Temperature Deg. F. | Latent Heat of Evap. in B. T. U. | Total Heat above 32° F. B. T. U. | Volume of 1 lb. in Cu. ft. | Weight of 1 cu. ft. in pounds. |
|---|---|---|---|---|---|---|
| 27.88 | 1 | 101.83 | 1034.6 | 1104.4 | 333.0 | 0.00300 |
| 25.85 | 2 | 126.15 | 1021.0 | 1115.0 | 173.5 | 0.00576 |
| 23.81 | 3 | 141.52 | 1012.3 | 1121.6 | 118.5 | 0.00845 |
| 21.78 | 4 | 153.01 | 1005.7 | 1126.5 | 90.5 | 0.01107 |
| 19.74 | 5 | 162.28 | 1000.3 | 1130.5 | 73.33 | 0.01364 |
| 17.70 | 6 | 170.06 | 995.8 | 1133.7 | 61.89 | 0.01616 |
| 15.67 | 7 | 176.85 | 991.8 | 1136.5 | 53.56 | 0.01867 |
| 13.63 | 8 | 182.86 | 988.2 | 1139.0 | 47.27 | 0.02115 |
| 11.60 | 9 | 188.27 | 985.0 | 1141.1 | 42.36 | 0.02361 |
| 9.56 | 10 | 193.22 | 982.0 | 1143.1 | 38.38 | 0.02606 |
| 7.52 | 11 | 197.75 | 979.2 | 1144.9 | 35.10 | 0.02849 |
| 5.49 | 12 | 201.96 | 976.6 | 1146.5 | 32.36 | 0.03090 |
| 3.45 | 13 | 205.87 | 974.2 | 1148.0 | 30.03 | 0.03330 |
| 1.42 | 14 | 209.55 | 971.9 | 1149.4 | 28.02 | 0.03569 |
| 0 lbs. gauge | 14.7 | 212.0° | 970.4 | 1150.4 | 26.79 | 0.03732 |
| .3 | 15 | 213.0 | 969.7 | 1150.7 | 26.27 | 0.03806 |
| 1.3 | 16 | 216.3 | 967.6 | 1152.0 | 24.79 | 0.04042 |
| 2.3 | 17 | 219.4 | 965.6 | 1153.1 | 23.38 | 0.04277 |
| 3.3 | 18 | 222.4 | 963.7 | 1154.2 | 22.16 | 0.04512 |
| 4.3 | 19 | 225.2 | 961.8 | 1155.2 | 21.07 | 0.04746 |
| 5.3 | 20 | 228.0 | 960.0 | 1156.2 | 20.08 | 0.04980 |
| 6.3 | 21 | 230.6 | 958.3 | 1157.1 | 19.18 | 0.05213 |
| 7.3 | 22 | 233.1 | 956.7 | 1158.0 | 18.37 | 0.05445 |
| 8.3 | 23 | 235.5 | 955.1 | 1158.8 | 17.62 | 0.05676 |
| 9.3 | 24 | 237.8 | 953.5 | 1159.6 | 16.93 | 0.05907 |
| 10.3 | 25 | 240.1 | 952.0 | 1160.4 | 16.30 | 0.0614 |
| 11.3 | 26 | 242.2 | 950.6 | 1161.2 | 15.72 | 0.0636 |
| 12.3 | 27 | 244.4 | 949.2 | 1161.9 | 15.18 | 0.0659 |
| 13.3 | 28 | 246.4 | 947.8 | 1162.6 | 14.67 | 0.0682 |
| 14.3 | 29 | 248.4 | 946.4 | 1163.2 | 14.19 | 0.0705 |
| 15.3 | 30 | 250.3 | 945.1 | 1163.9 | 13.74 | 0.0728 |
| 16.3 | 31 | 252.2 | 943.8 | 1164.5 | 13.32 | 0.0751 |
| 17.3 | 32 | 254.1 | 942.5 | 1165.1 | 12.93 | 0.0773 |
| 18.3 | 33 | 255.8 | 941.3 | 1165.7 | 12.57 | 0.0795 |
| 19.3 | 34 | 257.6 | 940.1 | 1166.3 | 12.22 | 0.0818 |
| 20.3 | 35 | 259.3 | 938.9 | 1166.8 | 11.89 | 0.0841 |
| 21.3 | 36 | 261.0 | 937.7 | 1167.3 | 11.58 | 0.0863 |
| 22.3 | 37 | 262.6 | 936.6 | 1167.8 | 11.29 | 0.0886 |
| 23.3 | 38 | 264.2 | 935.5 | 1168.4 | 11.01 | 0.0908 |
| 24.3 | 39 | 265.8 | 934.4 | 1168.9 | 10.74 | 0.0931 |
| 25.3 | 40 | 267.3 | 933.3 | 1169.4 | 10.49 | 0.0953 |
| 26.3 | 41 | 268.7 | 932.2 | 1169.8 | 10.25 | 0.0976 |
| 27.3 | 42 | 270.2 | 931.2 | 1170.3 | 10.02 | 0.0998 |
| 28.3 | 43 | 271.7 | 930.2 | 1170.7 | 9.80 | 0.1020 |
| 29.3 | 44 | 273.1 | 929.2 | 1171.2 | 9.59 | 0.1043 |
| 30.3 | 45 | 274.5 | 928.2 | 1171.6 | 9.39 | 0.1005 |
| 35.3 | 50 | 281.0 | 923.5 | 1173.6 | 8.51 | 0.1175 |
| 40.3 | 55 | 287.1 | 919.0 | 1175.4 | 7.78 | 0.1285 |
| 45.3 | 60 | 292.7 | 914.9 | 1177.0 | 7.17 | 0.1394 |
| 50.3 | 65 | 298.0 | 911.0 | 1178.5 | 6.65 | 0.1503 |
| 55.3 | 70 | 302.9 | 907.2 | 1179.8 | 6.20 | 0.1612 |
| 60.3 | 75 | 307.6 | 903.7 | 1181.1 | 5.81 | 0.1721 |
| 65.3 | 80 | 312.0 | 900.3 | 1182.3 | 5.47 | 0.1829 |
| 70.3 | 85 | 316.3 | 897.1 | 1183.4 | 5.16 | 0.1937 |
| 75.3 | 90 | 320.3 | 893.9 | 1184.4 | 4.89 | 0.2044 |
| 80.3 | 95 | 324.1 | 890.9 | 1185.4 | 4.65 | 0.2151 |
| 85.3 | 100 | 327.8 | 888.0 | 1186.3 | 4.429 | 0.2258 |
| 89.3 | 104 | 330.7 | 885.8 | 1187.0 | 4.268 | 0.2343 |
| 95.3 | 110 | 334.8 | 882.5 | 1188.0 | 4.047 | 0.2472 |
| 99.3 | 114 | 337.4 | 880.4 | 1188.7 | 3.912 | 0.2556 |
| 109.3 | 124 | 343.8 | 875.2 | 1190.1 | 3.611 | 0.2769 |
| 120.3 | 135 | 350.3 | 869.9 | 1191.6 | 3.331 | 0.3002 |
| 130.3 | 145 | 355.8 | 865.4 | 1192.8 | 3.112 | 0.3213 |
| 140.3 | 155 | 361.0 | 861.0 | 1194.0 | 2.920 | 0.3425 |
| 150.3 | 165 | 366.0 | 856.8 | 1195.0 | 2.753 | 0.3633 |
| 160.3 | 175 | 370.8 | 852.7 | 1195.9 | 2.602 | 0.3843 |
| 170.3 | 185 | 375.4 | 848.8 | 1196.8 | 2.468 | 0.4052 |
| 180.3 | 195 | 379.8 | 845.0 | 1197.7 | 2.346 | 0.4262 |
| 190.3 | 205 | 384.0 | 841.4 | 1195.5 | 2.237 | 0.443 |
| 200.3 | 215 | 388.0 | 837.9 | 1199.2 | 2.138 | 0.468 |

## CHLORIDE OF CALCIUM

| Specific Gravity at 60° F. | Degrees Beaume at 60° F. | Degrees Salometer at 60° F. | Pounds Calcium to each Cubic Foot Brine. | Freezing Point Degrees F. | Ammonia Gauge Pressure in Pounds at Freezing Point. |
|---|---|---|---|---|---|
| 1.007 | 1 | 4 | 1 | +31 | 46 |
| 1.014 | 2 | 8 | 2 | 30 | 45 |
| 1.021 | 3 | 12 | 3 | 29 | 44 |
| 1.028 | 4 | 16 | 4 | 28.5 | 43 |
| 1.035 | 5 | 20 | 5 | 28 | 42 |
| 1.043 | 6 | 24 | 7 | 27 | 41 |
| 1.060 | 8 | 32 | 8 | 25 | 38 |
| 1.073 | 10 | 40 | 9 | 22 | 35 |
| 1.089 | 12 | 48 | 10 | 19 | 32 |
| 1.105 | 14 | 56 | 12 | 16 | 29 |
| 1.122 | 16 | 64 | 14 | 12 | 25 |
| 1.140 | 18 | 72 | 16 | 8 | 21 |
| 1.167 | 21 | 84 | 18 | 0 | 15 |
| 1.186 | 23 | 92 | 22 | — 8 | 10.5 |
| 1.205 | 25 | 100 | 23 | —15 | 6 |
| 1.225 | 27 | 108 | 27 | —24 | 1.5 |
| 1.250 | 29 | 116 | 30 | —33 | 5″ vacuum |
| 1.268 | 31 | 121 | 32 | —47 | 12″ vacuum |
| 1.279 maximum | 32 | 124 | 34 density | —54 | 12″ vacuum |

NOTE—There is a slight difference in the quality of calcium made by the different manufacturers, requiring different quantities to give the same freezing point. The above figures are taken from an average and are near enough correct for ordinary calculations.

# PROPERTIES OF SOLUTIONS OF CHLORIDE OF SODIUM (COMMON SALT)

| Percentage of Salt by Weight | Pounds of Salt Per Gallon of Solution | Degrees on Salometer at 60° F. | Weight Per Gallon at 39° F. =4°C. | Specific Gravity at 39° F. =4°C. | Specific Heat | Freezing Point F. |
|---|---|---|---|---|---|---|
| 1 | 0.084 | 4 | 8.40 | 1.007 | 0.992 | 30.5 |
| 2 | 0.169 | 8 | 8.46 | 1.015 | 0.984 | 29.3 |
| 2.5 | 0.212 | 10 | 8.50 | 1.019 | 0.980 | 28.6 |
| 3 | 0.256 | 12 | 8.53 | 1.023 | 0.976 | 27.8 |
| 3.5 | 0.300 | 14 | 8.56 | 1.026 | 0.972 | 27.1 |
| 4 | 0.344 | 16 | 8.59 | 1.030 | 0.968 | 26.6 |
| 5 | 0.433 | 20 | 8.65 | 1.037 | 0.960 | 25.2 |
| 6 | 0.523 | 24 | 8.72 | 1.045 | 0.946 | 23.9 |
| 7 | 0.617 | 28 | 8.78 | 1.053 | 0.932 | 22.5 |
| 8 | 0.708 | 32 | 8.85 | 1.061 | 0.919 | 21.2 |
| 9 | 0.802 | 36 | 8.91 | 1.068 | 0.905 | 19.9 |
| 10 | 0.897 | 40 | 8.97 | 1.076 | 0.892 | 18.7 |
| 12 | 1.092 | 48 | 9.10 | 1.091 | 0.874 | 16.0 |
| 15 | 1.389 | 60 | 9.26 | 1.115 | 0.855 | 12.2 |
| 20 | 1.928 | 80 | 9.64 | 1.155 | 0.829 | 6.1 |
| 24 | 2.376 | 96 | 9.90 | 1.187 | 0.795 | 1.2 |
| 25 | 2.488 | 100 | 9.97 | 1.196 | 0.783 | 0.5 |
| 26 | 2.610 | 104 | 10.04 | 1.204 | 0.771 | —1.1 |

# PUBLISHER'S PAGE

Frick Company
WAYNESBORO, PA., U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

Main Office and Works:
Waynesboro, Pa.

Established 1853
Capital $2,000,000

Incorporated 1885
Net Resources $3,500,000

## BRANCH OFFICES

Where Prices and Information May be Obtained

| | |
|---|---|
| New York, N. Y. | 39 Cortlandt Street |
| Pittsburgh, Pa. | 631 Jenkins Arcade |
| Philadelphia, Pa. | 2320 Sansom Street |
| Baltimore, Md. | 610 American Building |
| Atlanta, Ga. | 406 Atlanta National Bank Building |
| Dallas, Texas | 807 Sumpter Building |

## SALES FACTORS OPERATING AT THIS TIME

| | |
|---|---|
| Baltimore Construction & Supply Company | Baltimore, Md. |
| Detroit Ice Machine Company | Detroit, Mich. |
| Edwards Ice Machine & Supply Company | Seattle, Wash. |
| Faget Engineering Company | San Francisco, Cal. |
| Memphis Engineering & Supply Company | Memphis, Tenn. |
| Mollenberg-Betz Machine Company | Buffalo, N. Y. |
| Refrigerating Machinery Company | New Haven, Conn. |
| San Antonio Machine & Supply Company | San Antonio, Texas |
| A. M. Lockett & Company | New Orleans, La. |
| Arthur Meltzer | Los Angeles, Cal. |
| C. M. Robinson Company | Cincinnati, Ohio |
| Bernard Gloekler | Pittsburgh, Pa. |
| Dairymen's Supply & Construction Company | Pittsburgh, Pa. |
| Tait & Nordmeyer Engineering Company | St. Louis, Mo. |
| Midwest Engineering & Equipment Company | Chicago, Ill. |
| T. J. Barnett Company | Palatka, Fla. |
| F. W. Hallam Engineering & Construction Company | Brooklyn, N. Y. |